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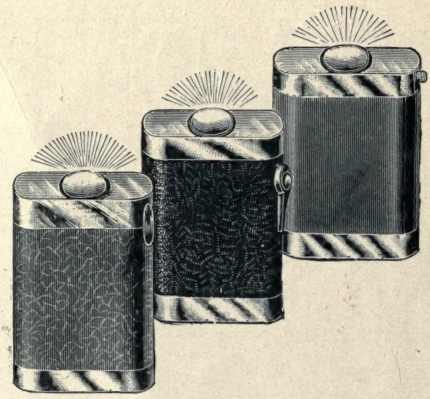

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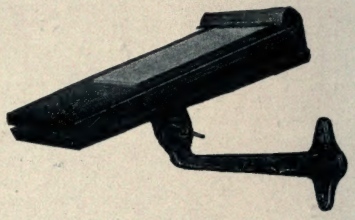

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TABLE OF CONTENTS

NOVEMBER, 1904

	Page
The Making of the Panama Canal. By Waldon Fawcett	265
Gunnery in the American Navy. By William Barlow	275
Modern Shop and Factory Lighting. By Frederick W. Turner	283
The Workman. Poem. By Robert Bridges	290
The Automobile in War. By Arthur Murchison	291
Making a Talking Machine. By Day Allen Willey	295
Great Technical Schools. Purdue University, Lafayette, Ind. By Fritz B. Ernst, B. S.	300
Greatest Stone Arch in America. Cabin John Bridge. By Guy Elliott Mitchell	309
George Frisbie Hoar. A Tribute. By Frank W. Gunsaulus, President, Armour Institute of Technology	312
Chalk Talks. No. IX. Refrigeration. By Carl S. Dow, S. B.	314
Editorial Department	
The Late Senator Hoar	316
Sea-Level or Lock Canal—Which?	317
The Block Signal System	317
France's Liberal Auto Laws	318
Last Big World's Fair	319
A Triumph in Metallurgy. By Florence King	320
Lines on Lines. Poem	322
Noon-Hour Talks. The Virtue of Self-Esteem	323
The Wagner Theater at Baireuth	325
Life Stories of Successful Men. Herbert H. Vreeland. By Henry M. Hyde	326
Professor Bell's New Kites. By George Campbell	329
Magnetic Clutches. By John S. McKee	331
Dinner-Pail Philosophy	333
Engineering Progress	
Fireproof Paint	334
Replacing a Railroad Bridge	334
Mammoth Steamer Boilers	336
Concrete Bridge	336
Shifting Right of Way	337
Marvelous Pumping Machine	337
Electric Railway Signals	338
New French Bridges	339
Speed Indicator	339
Science and Invention	
Pictures Without Lenses	340
Mechanical Paderewskis	341
Car-Journal Oiler	342
Trolley-Car Battleship	342
A New Sediment Trap	343
As Others Might See Us	343
Self-Starting Single-Phase Motor	344
Efficient Machine Vise	345
A Radium Clock	345
Industry and Commerce	
Latest in Mural Decorations	346
Cost of Firing Cannon	347
State Monopolies in France	347
A Chinese Printer's Task	348
The Telephone in the Alps	348
Egyptian Rags	348
Lay Excursions in Science. Second Paper. By Charles Pierce Burton	349
Costume and Custom	351
Metals Under the Microscope	353
Technical Training Pays	355
The Turbine Steamer "Brighton"	356
Do It Now. Poem	357
The Suez Canal	358
A Hero. Poem	359
The Embryo Electrical Engineer	360
Consulting Department	361
Personal and Miscellaneous	367
Employment Department	374
Literature	380

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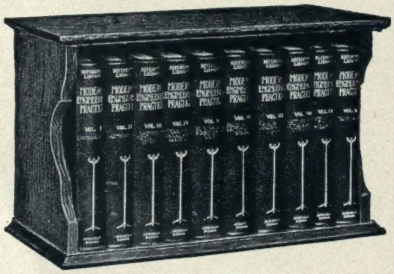

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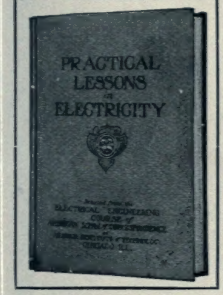

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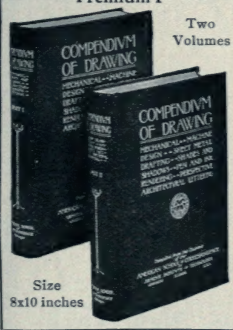

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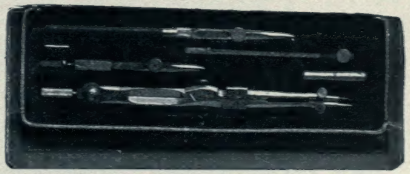

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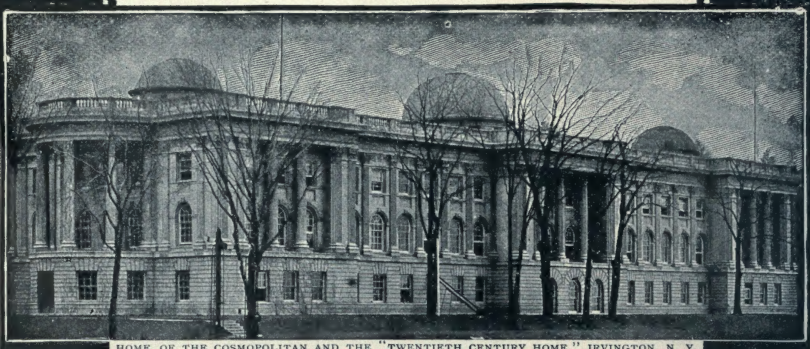

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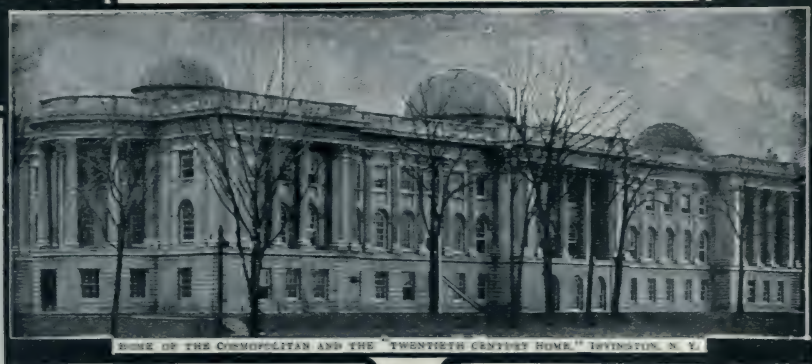

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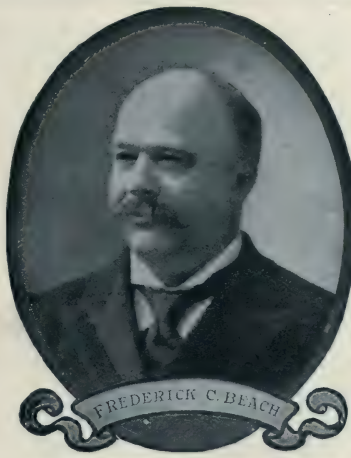

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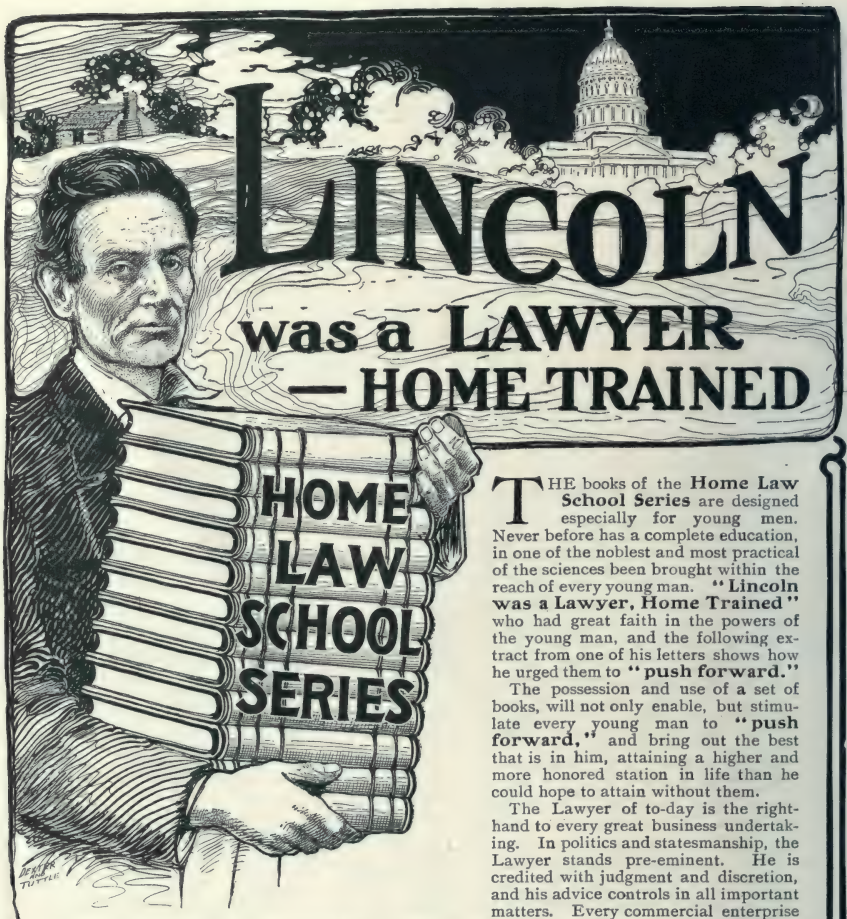

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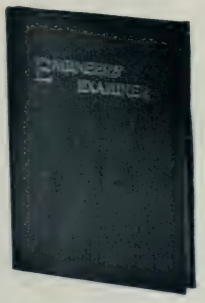

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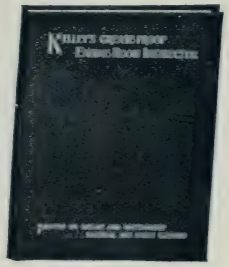

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Volume II NOVEMBER, 1904 No. 3

The Making of the Panama Canal

Difficulties that Confront American Engineers

By WALDON FAWCETT

IT AUGURS WELL for the successful completion of the Panama Canal project in the shortest possible space of time, that investigation and preparation admirable in its systematic thoroughness has characterized all the preliminaries. It is safe to predict that there will be none of the costly errors which led the French engineers and contractors to transport to the Isthmus expensive equipment ere they had positive information as to its adaptability to the work in hand; and it is unlikely that this undertaking to connect the Atlantic and Pacific oceans will be characterized by that lack of preparedness which has hampered several other notable engineering projects within the memory of the present generation. In this cutting of the continent which means so much to the people of the New World, the proverbial and admirable energy and enthusiasm characteristic of American enterprise are being tempered by a disposition to make sure of the right course ere proceeding upon it.

The Problem of Sanitation

Few persons not on the scene can have any conception of the magnitude of the task of merely paving the way for the work of actual construction—involving, as it will, an expenditure of time and labor which will scarcely show upon the surface, and the necessity of which is but remotely realized by a public impatient for actual progress toward the main object in view. The first step of all has imperatively been in the direction of better sanitary conditions at the Isthmus.

When the present Panama Canal Commission assumed control of the new territory which had but lately come under the jurisdiction of the Stars and Stripes, the health conditions at the Isthmus were just about as bad as they could possibly be. There may be some exaggeration in the claim that every mile of canal work performed by the French contractors cost the lives of a thousand men; but certain it is that Panama, until the dawn of this present era, was a hotbed of pestilence, reeking with leprosy, beri-beri, yellow fever, and every other type of virulent disease.

The population of the new-born Republic of Panama is made up of various elements comprising Jamaica negroes, about 20 per cent; native negroes, 40 per cent; Chinese, 5 per cent; and, finally white natives and foreigners, about 35 per cent. Of the white foreigners, the majority came to Panama during the time covered by the French attempts to construct the canal. All classes alike, however, have seemingly become reconciled to an utter absence of anything like

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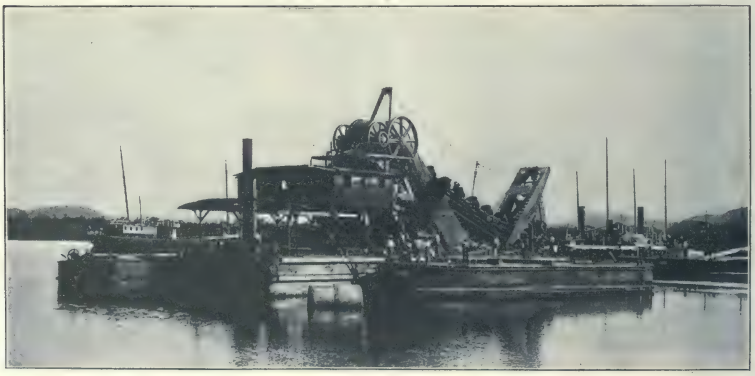
A STREET IN PANAMA.

proper regard for health conditions in the city of Panama and in the towns along the proposed line of the canal. For instance, in Panama City there has been no compulsory isolation of lepers; the sewerage system is wretched, the drains being filled with masses of decaying matter; and, in the dry season, the deficiency of the water supply has caused this necessary of life and public safety to sell for one cent a gallon, thus preventing the poor people—and most of the inhabitants come under that category—from taking baths save at long intervals.

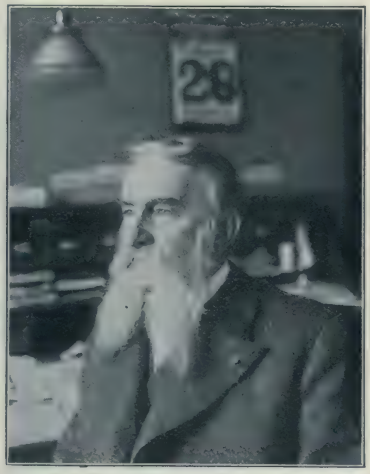
Bad as conditions appeared at the outset, the Commissioners declared, after a thorough investigation, that Panama could be made as healthful as any tropical country. Americans had performed seeming miracles under similar condi-



STEAM DREDGES LYING AT PACIFIC TERMINUS OF PANAMA CANAL.

Part of this machinery, which was used by the French companies, though rather antiquated and in poor condition from neglect, may be available for use by American engineers.

tions elsewhere—notably in Cuba—and they could do it here. The man chosen to direct this great campaign for cleansing the Isthmus was above all others the best qualified for the task. Col. W. C.



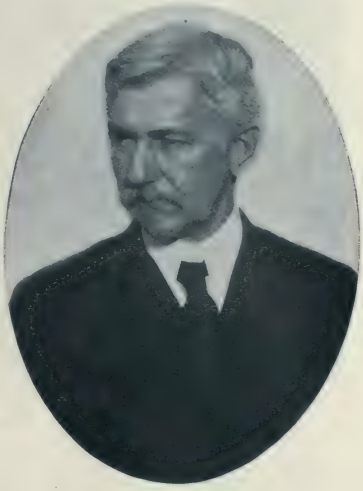
REAR-ADMIRAL J. G. WALKER.
President, Panama Canal Commission.

Gorgas of the United States Army is a recognized authority on yellow fever and other such diseases; and his remarkable work in Havana during the American occupation of Cuba stamped him as preeminently the man to shape the sanitary policy of the canal zone.

The sanitation of Panama will, it is estimated, entail an expense of fully $2,000,000. In Panama, with semi-military control, considerable progress is already being made in enforcing adoption of the ordinary means of sanitation, such as keeping the streets clean and inducing greater cleanliness in private dwellings—many of the latter being disease-breeding structures of stone which have stood for two hundred years.

The next step is to provide an abundance of good water and install a sewerage system. There is plenty of pure water in the mountains; and while it is not yet definitely determined whether the supply will have to be piped sixty miles or only twenty miles, it is certain that it will be obtained, and that Panama will be provided with an up-to-date waterworks plant.

At Colon, the seaport on the Atlantic, the city must be raised out of a marsh. To do this, it will be necessary to fill in the island of Manzanillo, on which the town stands, so that it will be less of a swamp and, if practicable, will be elevated above sea-level. This will involve no serious problem of sanitary engineering. It is simply a question of procuring sufficient dirt for filling purposes. Moreover, inasmuch as Colon, since the fire of 1885, has been a city of frame buildings, it will accommodate itself to the proposed changes much more readily than would a city of more stable construction. It is estimated that fully $500,000 will be expended in sanitary work during the first year; and the policing of the canal zone, which will have as one of its main objects the enforcing of better sanitary conditions, will probably cost about $300,000 a



COL. W. C. GORGAS.
American Expert Engineer in Charge of Sanitary Work at the Isthmus.

year during the entire period of eight or nine years that the canal will be under construction.

Preliminary Surveys and Estimates

Next to the sanitary problem, an important branch of the preliminaries is found in the preparation of surveys and estimates. These are of double import-

ance in the case of the Panama project, owing to the fact that in certain portions of the work a decision must be made from among as many as five different plans, taking into consideration questions of economy and commercial advantages. Moreover, to determine the cost of locks and dams will require extensive borings.

Harbor Improvements

Yet another phase of what might be designated as the "preliminaries" of this vast project, is found in the necessity for harbor improvements at Panama and Colon, and the provision of wharves and docks adequate for the handling of the vast quantities of material and supplies which will be unloaded at these points for use in the canal construction work. At Colon the harbor must be so improved that ships can lie there at all seasons of the year; and virtually a new harbor must be provided at Panama, where the present harbor is little more than an open, shallow roadstead. Then, too, the canal must be extended by dredging or by the construction of quays out into the deeper water of Panama Bay.

The Problem of Excavation

But it must not be supposed that the actual work upon the canal proper will wait upon these introductory projects, extensive as they are. The two French companies which had a hand in the canal work excavated about 7,000,000 cubic yards of the proposed waterway, of which amount perhaps two-thirds will now prove of value, leaving about 100,000,000 cubic yards yet to be excavated. Upon the problems involved in the execution of this gigantic task, the engineers in charge are even now hard at work. The man who is at the head of this branch of the work—Chief Engineer John F. Wallace, of Chicago, Illinois, late General Manager of the Illinois Central Railroad—is in every respect the exceptional man who is needed for this exceptional work.

Mr. Wallace did not undertake his present duties a stranger to the situation which confronts him at the Isthmus.

SOME OF THE LEADERS OF THE NEW REPUBLIC OF PANAMA.
President Amador seated in center.

WHERE SOME IMPORTANT WORK HAS BEEN DONE.

Present Appearance of a Section on Route of Panama Canal.

Some eight years ago he visited Panama and made a most exhaustive study of the great engineering problem of the age, and of the methods which were being used or might be used for its solution; but his trip at that time was, of course, simply one of research by a man interested in his profession, and was undertaken without the slightest suspicion that he should ever be called upon to become personally responsible for the discharge of a task which had baffled so many capable engineers.

JOHN F. WALLACE was born at Fall River, Mass., and was educated as a civil engineer at Monmouth College, Monmouth, Ill., of which institution his father, Rev. David A. Wallace, was the founder and first president. In 1869 he entered the service of the Carthage & Quincy Railroad as rodsman, and a year later was assistant engineer on surveys on another railroad. From 1871 to 1876 he was assistant engineer in the United States Engineering Corps at Rock Island, and during this interim constructed with machinery of his own design a channel through the St. Louis chain of rocks, an undertaking in which the Government had previously failed. Then followed important engineering work for the Union Pacific Railroad in the Rocky Mountains, and for the Santa Fé Railroad, and, finally, his long connection with the Illinois Central Railroad, terminating in his occupancy of the post of General Manager, a position which he resigned to assume his duties at Panama, although his present salary of $25,000 per year is considerably less than he heretofore received. For portrait of Mr. Wallace, see THE TECHNICAL WORLD, Vol. I, No. 5, July, 1904.

River Diversion and Reservoir Construction

Not a few problems other than those involving actual canal construction work confront Engineer Wallace and his assistants. Among these is the necessity

MAP OF PANAMA CANAL ROUTE.

for the diversion and control of the waters of the Chagres River, which follows the route of the canal for twenty miles, and which at certain seasons of

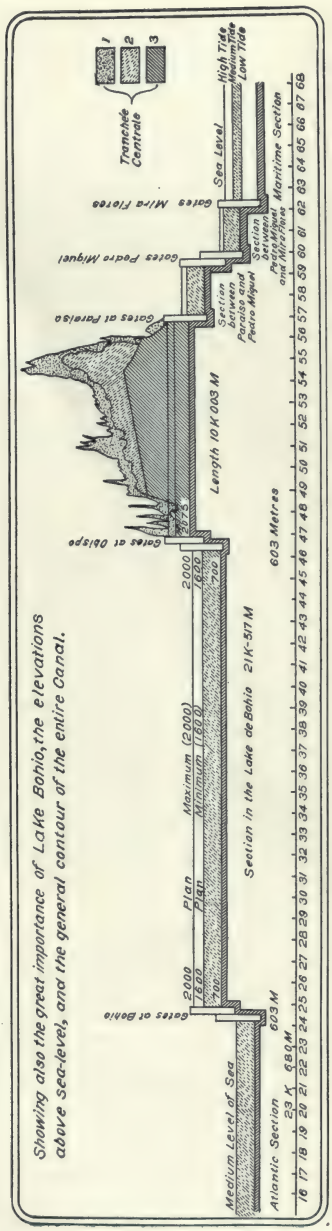

Showing also the great importance of Lake Bohio, the elevations above sea-level, and the general contour of the entire Canal.
Tranchée Centrale
High Tide
Low Tide
Sea Level
Gates M/ra Flores
Gates Pedro Miguel
Gates at Paraiso
Gates at Obispo
Gates at Bohio
Length 10 K 003 M
603 Metres
Section in the Lake de Bohio 21K-517 M
Plan Maximum (2000) Minimum (1600)
Plan
Medium Level of Sea
Atlantic Section 33 K 680 M 603 M
Section between Paraiso and Pedro Miguel
Section between Pedro Miguel and Miraflores
Maritime Section

DIAGRAM SHOWING LOCK SYSTEM, PANAMA CANAL, FROM COMMISSION'S RELIEF MAP.

the year is subject to sudden freshets that cause the river to rise from twenty to sixty feet in the course of twenty-four hours. Another incidental is the necessity for the construction in the mountains of immense reservoirs to provide a water supply for the high-level locks of the canal; and yet other reservoirs must be constructed to provide water-power for developing electricity. The canal is to be lighted by electricity throughout its entire length; and in addition electrical power will be used for operating much of the machinery employed in the work of constructing the canal.

The Culebra Cut

In the construction work proper, the finest points of engineering are involved in the handling of operations in the "top reach" or highest section of the canal. This "top reach" involves the completion of the famous Culebra Cut, the most noted and pre-eminently the most difficult section of the canal. The tedious character of this portion of the work is due largely to the extremely rocky formation. The Culebra Cut, which is the only portion of the new waterway upon which work was in progress when the project was taken over by the American Government—a force of 900 Jamaica negroes having been retained at this point by the French company—is about eight miles in length, extending from the Obispo gates, which lie between thirty-one and thirty-two miles from Colon, to the Pedro Miguel locks, situated a little more than six miles from Panama. The highest point on the route is about five miles from the Obispo gates, where the bottom of the canal is 274 feet below the surface of the ground at the sides of the cutting. To the eye of the ordinary visitor this famous cut would appear to be already low enough and wide enough for the purposes of the canal, but actual measurement proves it to be only about one-half completed.

Assets Acquired from the French

Just here it may be of interest to review briefly the assets, in work accomplished and equipment, which the French companies have turned over to their Yankee successors. Almost the whole length of the canal has been cut to some extent by the French, and several miles on the

WASH DAY.—A TYPICAL SCENE ALONG THE LINE OF THE PANAMA CANAL.

Atlantic side are open and navigable from the sea. The rapid tropical growth of vegetation hides much of the work, but it is there.

Easily one of the most valuable acquisitions which the United States Government made by its purchase of the French concession, is found in the mass of minute and painstaking charts and books recording in detail the results of years of experience and experiment in the making of soundings, borings, and surveys; flood measurements; rain gauges; labor showings; records of the working capacities of various types of machinery under Isthmian conditions, etc.

A TYPICAL PANAMA FAMILY.

CUT ON LINE OF PANAMA CANAL.

Showing some of the Revolving Derricks used by the French.

THE FAMOUS CULEBRA CUT AS IT APPEARS AT PRESENT.

Situated at the Summit of the Isthmian Divide.

What might be termed the more tangible property acquired, does not appear especially valuable; but in reality it is of far greater avail than might at first seem possible. For instance, there are 2,400 buildings for workmen and officials, which are almost without exception in fine condition and would cost an immense sum to replace, to say nothing of the delay that would be involved were it necessary to construct them anew. Some of the excavating machinery is antiquated or impracticable in the eyes of the American engineers; but the property turned over by the French comprises hundreds of locomotives and numberless dump trains, which either are capable of efficient service or can readily be rendered so.

A BEND IN THE CHAGRES RIVER.

Source of Water Supply for the Proposed High Locks of the Panama Canal.

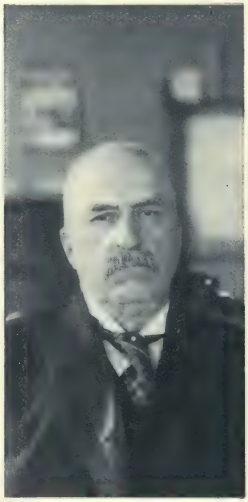
The Panama Railroad

The Panama Railroad, considered as a whole, is perhaps the best single asset transferred to Uncle Sam's ownership. The line, which is about forty-seven miles in length, extends across the Isthmus from Panama on the Pacific to Colon on the Atlantic. From the standpoint of both roadbed and rolling stock, it ranks as a very good road and one which is and has been excellently managed. In the past there has been much complaint about the administration of this railroad, for the reason that not only were the freight and passenger tariffs exorbitant, but the charge for a given service varied greatly according to whether the traveler purchased a through ticket in New York or San Francisco or waited until reaching the Isthmus to

UNLOADING SUPPLIES AT TERMINUS OF PANAMA RAILROAD.

arrange for transportation. Under American control, however, these errors of administration will be remedied.

The present railroad line between Colon and Panama, with the additional demands that will be made on it as a result of the construction of the waterway, is sure to require increased facilities for handling the international traffic until the canal is opened; and there are other railroad projects in Panama which will have an important bearing, direct or indirect, upon the canal. There is, for example, a project for a line from Chiriqui and David on the Pacific slope to Panama; and there is also on foot a proposition for a line from Bocas del Toro through the fruit belt to the middle of the canal zone. This latter would be the natural continuation of the line projected along the Atlantic coast from Costa Rica.



MAJ.-GEN. GEO. W. DAVIS., U. S. A.

Governor of the Canal Zone.

The Canal Zone

In conclusion a word may be said regarding the governing of the "Canal Zone"—the portion of the Isthmus in which the new waterway is located and the adjacent portions of the territory of the new republic which are directly under the jurisdiction of the United States For the time being, at least, the Isthmian Commission exercises legislative authority over the canal zone; and Gen. George W. Davis, the Army member of the Commission, acts as Governor. He has the power to appoint the judges who exercise judicial authority, to grant reprieves and pardons, and to call upon any available military or naval force for assistance in enforcing the laws.

As the work of constructing the canal is actually entered upon, the question of the government of the canal zone will doubtless become much more complicated than at present, for it is estimated that fully 40,000 day laborers will eventually be continuously engaged upon the work. The majority of these will be negroes from the West Indies, particularly from Jamaica—a class of toilers requiring careful management; and Chinese laborers, who were employed in building the railroad fifty years ago, will also be utilized to some extent, as will also Japanese coolies. This intermingling of races will in itself be calculated to give rise to more or less trouble unless the great army of workers is controlled by a firm hand. The present indications are that there will be opportunities of employment for only a comparatively limited number of Americans in connection with the actual work of construction.

Gunnery in the American Navy

Course of Instruction and Drill that makes the American "Jackie" the Best Marksman in the World.

By WILLIAM BARLOW

THE EVENTS of the Spanish-American war raised immeasurably the world's estimate of American naval gunnery, and they also served as an incentive to deepened interest on the part of Uncle Sam's gunners in that target practice which is largely responsible for the Yankee reputation for the best marksmanship in the world. Of course it is not meant to imply that either creditable target practice or excellent marksmanship under war conditions dated only from the recent conflict; but, perhaps, the events of the past half-dozen years have won more general and more generous recognition from other leading nations than had previously been accorded.

The Man Behind the Gun

American naval gunners have won fame in every war in which the nation has engaged, by reason of the accuracy of their aim. Upwards of a century ago the men of the infant United States Navy gave an illuminating object-lesson of the superiority of sea fighters who have been trained by regular and continuous target practice over those who have not obtained this essential element of preparedness—for the British, although the supposed champions of the high seas, had at that time but a single ship on which target practice had been indulged in, or whose guns had even been fitted with sights.

The battle of the Yalu in the Chinese-Japanese War, with its disclosure of the new modern conditions in naval warfare, was a spur to the later advance and development of naval gunnery under the Stars and Stripes; and how effectual has been the progress under present-day conditions, was eloquently attested at Manila and Santiago.

In naval gunnery, as in everything else, the American method places chief reliance upon the human factor. The *man behind the gun* is deemed far and away the most important single element of success; and with such estimate, it is perhaps natural that the scientific and technical training of the gunners in the United States Navy should surpass in scope and thoroughness that accorded their rivals under any other flag.

COURTESY OF "COLLIER'S WEEKLY."

AFTER-GUN CREW WHO REFUSED TO CEASE FIRING AFTER ADMIRAL SAMPSON'S ORDER.

Certain naval officers are prone to argue that the ideal gun-pointer is born and not made; but, generally speaking, the knack of shooting straight—particularly that highly specialized ability which enables a bluejacket to train a heavy gun

GUN DRILL ON ONE OF THE OLD MONITORS.

upon a moving target, and hit it nine times out of ten even though the gun itself is mounted upon a moving and swaying platform—is an art that comes from practice rather than from chance, and the price of which is unremitting hard work. The training of the naval man in the all-important "rapidity of fire and accuracy of aim," begins as soon as he enters the Navy, and is kept up as long as he has aught to do with the work of pointing and discharging Uncle Sam's most potent peacemakers.

Courses of Instruction

The man behind the gun in the United States Navy as now constituted, is not only a seaman, qualified by a regular apprenticeship in the Navy, but is also an expert mechanic, an electrician, a student of the principles of steam engineering, and a man of thorough practical and theoretical knowledge of high explosives, torpedoes, and submarine mines. Since 1882 the United States Government has maintained regular schools for its gunners in connection with which the men not only acquire all the knowledge that can be learned from books, but also get practical instruction in the ordnance factories where our heavy weapons are manufactured.

The classes in gunnery are open to any young men who have served their time in the Navy as apprentices and received the rating of seamen, provided their records are good and they have shown themselves fitted for the advancement they seek. In the instruction courses the future gunner's work is divided under three heads—task, subject, and log. For each week of the course, there is a series of printed questions ranging in number from fifteen to sixty. Opposite each question is set down the place where the information can be obtained—whether in shop, drill, books, or from the instructor. Each question the ambitious sailor must set down in his log book, writing the answer out in full. He is marked on the completeness and correctness of his log.

Once each week the gunnery class undergoes examination on the work of the preceding seven days, and each student is

GUN DRILL ABOARD WAR VESSEL, BROOKLYN NAVY YARD.

rated according to his individual showing. The "task" portion of the curriculum consists of the assignment to the embryo gunners, of work to be performed each week in one or another of the shops where the manufacture of naval ordnance is carried on. For instance, a pupil may be assigned to construct a miniature gun, even to procuring the metal from the foundry and casting the gun mount, himself. In this manner he familiarizes himself with the machines in the shops, including lathes, shapers, and milling machines, and not only comes to know their uses but is able to use them himself.

In this very practical instruction work, guns are taken apart and reassembled, and the name of each part learned. Blue prints are also introduced, and the seaman taught the rudiments of technical draftsmanship. The young man who aspires to be a gunner works hard from 8 A. M. until 4:15 P. M., six days a week; but at the end of a four months' course he is able to go into a shop and reproduce any portion of a gun that has been broken. This portion of his new duties mastered, the young gunner is transferred to the governmental school at Newport, Rhode Island, where three months are devoted to the study of electricity and high explosives, particularly with reference to torpedoes and submarine mines.

The young man who has successfully passed the examinations at the conclusion of the gunnery course, and is ready to take up his duties as a gunner on a cruising warship, comes to the scene of his future activities qualified to do almost anything with a piece of naval ordnance except to shoot accurately with it. This ability comes only from target practice under conditions not to be found at any land station. Thus it comes about, that, with his appearance on shipboard, the newly qualified gunner enters upon a postgraduate course which is possibly the most valuable feature of the whole intensely practical system of instruction.

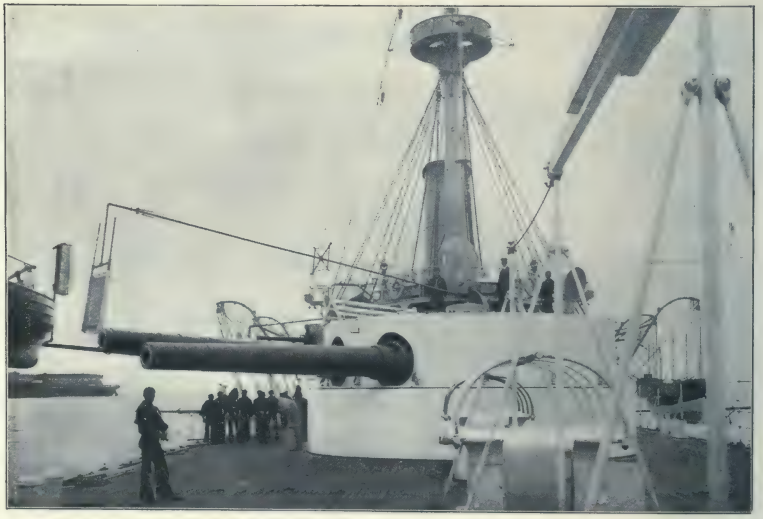
The guns of the United States Navy are divided into three classes—"heavy" guns, embracing 8-inch and larger rifles,

including, of course, the big 12-inch and 13-inch guns of our battleships; "intermediary" guns, ranging from the 4-inch to the 7-inch size inclusive; and "secondary" guns, embracing all the weapons of calibers below the 4-inch. Some versatile gunners may have a certain degree of proficiency in handling guns of all the different classes; but the tendency, as in every other present-day field of endeavor, is toward specialization, and the average expert gunner manifests his maximum skill in the manipulation of guns of a single caliber, or at least of one general class.

Inasmuch as ammunition for the largest naval guns represents an expenditure of approximately $500 per round, it goes without saying that gunners, in much of their training, cannot be permitted to use the charges that would be employed under actual war conditions. As a substitute, the Navy has what is known as "sub-caliber" practice. By this method, a small gun—ordinarily the Morris tube, which consists of a small gallery rifle—is fitted on or inside the heavy weapon; and practice starts with firing at a small target placed at reduced range. Of course the accuracy of eye and steadiness of nerve requisite in naval gunnery can be demonstrated in sub-caliber practice quite as conclusively as in the handling of the 12-inch or 13-inch rifles; and if a gunner has demonstrated his ability to hit a six-foot target at 100 yards with a missile from a one-pounder gun, it is fair to assume that he may be trusted to hit a full-sized ship a mile distant if he employs a breech-loading rifle of the first class.

The Dotter

Another plan for training men in gun-pointing is by means of what is known as the "dotter," a mechanical device of British invention, which causes a small target to move across the face of a gun with combined vertical and horizontal motion. The trick consists in making the gun follow the target, and, when the sights of the gun are on the bull's-eye, pressing the button, which causes a pencil to dot the target and thus register a hit. Hence the name of the "dotter."



DEVICE FOR SIGHTING GUNS IN TARGET PRACTICE.

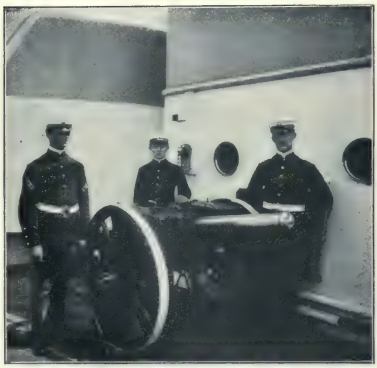
In connection with the "dotter" or the tube, the men are drilled in the use of the loading machine, for, in these days, rapidity of fire in the case of even the largest guns is in importance second only to accuracy of aim.

In this connection it may be explained that even the big 12-inch and 13-inch turret guns of our battleships have through recent advances been transformed into rapid-firers. In the old days of sails and smooth-bore guns, the one invariable rule in naval gun play was to fire at the top of the downward roll, or, in other words, to discharge the weapon just as the ship began to roll toward the target; and likewise it was the universal custom to aim at the water line of the enemy's ship. Under the now prevailing conditions, however, the naval gunner is trained wholly in "continuous-aim firing," as it is called—which means that he must be capable of keeping his great rifle continually trained on the target regardless of the oscillations of the vessel during the roll or any part of it. The necessity for this preparedness for continual performance will be better appreciated when it is stated that as late as five years ago the official time allowance in our Navy for firing a 13-inch gun was six minutes; whereas now, in actual target practice with full charges, our bluejackets load and fire a 13-inch gun in thirty-eight seconds.

Target Practice

To cultivate accuracy of aim under quick-firing conditions, two kinds of target practice are now employed. In one the target is stationary, the ship moving past it while firing; and in the other both ship and target are moving, usually in opposite directions. Under the first-mentioned plan, the target is towed to a distance of perhaps 2,000 yards from what might be called the "firing line," and is there so anchored that it will remain practically immovable. This target forms the apex of a triangle, the other two angles of which are marked by buoys. The war vessel steams at a speed of twelve or fifteen miles per hour along the base of this triangle; and projectiles are

AMERICAN BLUEJACKETS IN GUN DRILL ASHORE.



MARINES WITH GUN ABOARD WARSHIP.

hurled at the target as rapidly as the guns can be worked, during all the time the ship is between the two buoys that constitute, as it were, the boundaries of the range.

Under the other plan, the target is slowly towed in one direction, while the ship which is to indulge in target practice steams at a speed of about ten miles an hour along a parallel line in the opposite direction, and at a distance of about a mile from the line on which the target is moving. For this work it is customary to employ a target twenty feet long by sixteen feet high, which is trailed 500 yards behind the ship that is towing it.

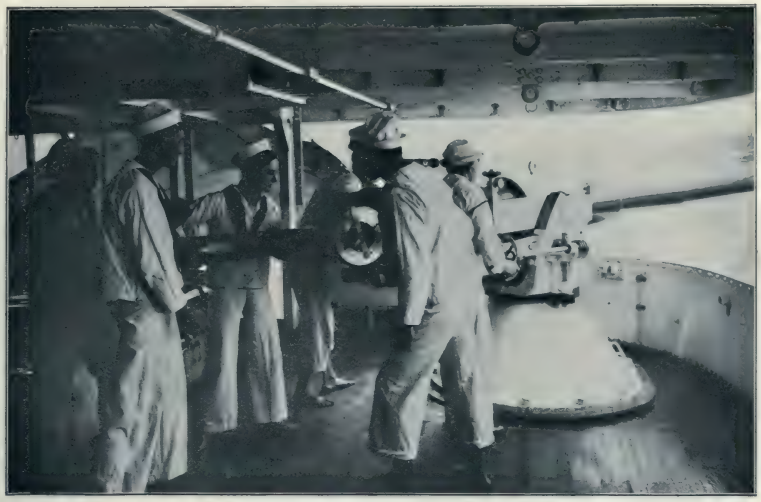
Targets, by the way, have differed widely in size during the history of our naval target practice. For half a century, or until a few years ago, the standard navy great gun target was a triangular sail 10 feet high and 10 feet wide at the base, mounted on a floating platform and bearing in the center a painted bull's-eye. Of late there has been a more extensive use of targets formed from rectangular sheets of white canvas 17 by 21 feet in size mounted upon floats, which serve their purpose most admirably for practice at distances ranging from 1,600 to 2,000 yards and with ships moving at a speed of 12 to 15 miles an hour. Occasionally American naval gunners have an opportunity to try their skill at pummeling an actual ship—as, for instance, an old condemned vessel; but the United States Government has not as yet gone to the lengths of the British and the French authorities, the latter of whom some time ago used one of their first-class battleships as a target for the other vessels of the fleet.

LOADING AMMUNITION ON BATTLESHIP "INDIANA."

COURTESY OF "COLLIER'S WEEKLY."

FIRST GUN CREW THAT SUNK SPANISH GUNBOAT OFF GUANTANAMO, CUBA.

There are not many features of naval target practice, however, wherein other nations can be said to excel or even equal



GUN DRILL ON MONITOR *FLORIDA.*

the United States. The American Government is expending approximately $1,500,000 a year to secure proficiency of marksmanship on the part of its naval gunners; and, when all the new war vessels now building are in commission, this annual expenditure will run up to $2,600,000. Aside from the expenditure for ammunition, there is a lavish outpouring of money to bring to the highest degree of efficiency the man behind the gun.

American naval gunners are the best clothed, best fed, and best paid men of their class in the world. A turret captain in charge of heavy guns receives as high as $70 per month—in addition, of course, to board, clothes, and lodging; and a first-class gun-pointer for one of the larger-sized guns is allowed $10 per month in addition to his regular wages, while the pointers of the smaller guns receive premiums of from $2 to $8 per month each. In addition to these emoluments, there are the splendid cash prizes which are open to every enlisted man in the Navy. For these prizes, Congress appropriates $200,000 a year; and how far in advance of every other nation we are in our incentives to good marksmanship, is evidenced by the fact that Great Britain, with her huge navy, appropriates only $26,000 per year for such prizes. In the American Navy there are three prizes for each class of gun on each ship, so that it is possible for almost every man who can shoot at all to win something. In addition there are magnificent trophies which are awarded to the ship in each class having the highest general score.

The reward for this elaborate training in naval gunnery is found in the remarkable scores made of late years by the gun

COURTESY OF "COLLIER'S WEEKLY."

MARINE GUARD INSPECTION ON THE "NEW YORK."

crews on vessels flying the Stars and Stripes. For instance, on the battleship *Alabama,* a 13-inch gun recently made two hits in two minutes at 1,600 yards; and on the battleship *Wisconsin* the gunners of one of the 13-inch weapons made nine hits out of ten shots at 1,700 yards. On another occasion one turret of the *Alabama* made fifteen hits out of sixteen shots, keeping up the hit-a-minute pace with the ponderous 13-inch shells almost

GUN CREW AT PRACTICE.

the entire time. That this marvelous proficiency is by no means confined to the men who manipulate the heavy guns, will be appreciated when the fact is cited that a 6-pounder on the battleship *Illinois* fired ten shots and made ten hits in thirty-three seconds.

Expeditious work in the magazine and at all stages of the handling of ammunition and the loading of the guns, is quite as important as accuracy of aim. The recent accident on the battleship *Missouri* acted, of course, as a slight damper of enthusiasm upon what had previously been one of the tasks in which Jack was especially proud of his deftness and skill; but, with the introduction of special devices for preventing a repetition of such an accident in either turret or handling room, the old spirit will return. The "loading machine"—which is used in all ammunition drills, is simply the breech of a dummy gun fitted with service mechanism, and into this the men are trained to load the regulation shell by hand and without the use of rammers. So expert do the men become that a well-trained crew will load a 5-inch gun in less than two seconds, keeping up this speed for intervals of considerable length.

In connection with the development of American naval gunnery, it is interesting to note the progress which has been made in armament. At the opening of the nineteenth century, vessels of the *Constitution* class were armed with long 24-pounders on the gun deck and 32-pounder carronades on the quarter-deck and forecastle. The frigates built from 1821 to 1847 carried long 32-pounders and short 8-inch guns. It was not until the Civil War that guns as large as 11-inch were used on our warships; and as recently as 1885 the armament of American men-of-war consisted principally of 11-inch and 9-inch smooth bores and 8-inch muzzle-loading rifles, there being at that time no plant in the United States capable of making forgings for a modern rifle of more than 6-inch caliber. To-day our naval ordnance factories are turning out 12-inch and 13-inch naval guns which are the peer of anything in the world.

CLIFF WALK, NEWPORT.

Modern Shop and Factory Lighting

Approved Methods and Fixtures

By FREDERICK W. TURNER

Instructor, Machine Shop Work, Mechanic Arts High School, Boston, Mass.

IT IS ONLY within a few years that what is now regarded as proper attention to lighting has been considered in the design and construction of factory buildings. In former years, a shop seemed to be designed more to protect the tools and materials from the weather, than to afford any degree of convenience or comfort for the workmen. It is now regarded as good business policy (in other words, it pays) to provide buildings which are properly heated, lighted, and ventilated. In such buildings, workmen are more content, do better work, and produce more of it. From the old-fashioned blacksmith shop, in which each smith was supposed to work by the light of his own fire, it is a far cry to shops such as those of the National Cash Register Company at Dayton, Ohio, in which the comfort and convenience of the employees has been given a degree of attention that would seem to old shop managers to partake of the nature of coddling.

WELSBACH MULTIPLE GAS ARC LAMP.

Distribution of Sunlight

In considering this question of lighting, it is well understood that daylight is the best light, especially when not accompanied by the direct rays of the sun. To distribute daylight properly over large areas, is the first problem to be considered. This can be accomplished in several different ways. Where buildings are several stories in height, and where light, except in the upper story, must be admitted from side windows, those windows should reach from the top of the bench to the ceiling. A given amount of glass arranged in this manner gives a much better general distribution of light than the same amount of glass put into the ordinary form of short windows. The amount of light in the center of the room depends very largely upon the height of windows at the side. All modern factory buildings are now lighted by long, narrow windows. The common type of shop, consisting of an open floor with a gallery on both sides, is usually lighted, in addition to the tall side windows, by glass in the sides of the monitor roof.

The best system of roof lighting is by means of what is termed a "saw-tooth" roof, the short and comparatively steep side of the tooth being composed wholly of glass. This glass should face as nearly north as possible, in order to avoid the direct sunlight. In this connection, it will be remembered how the workman of the old school, especially if employed on work requiring close application, always selected a north window, even if the view therefrom was not so pleasing as that from some other point of the compass.

WESTINGHOUSE SERIES-ALTERNATING ENCLOSED-ARC LAMP.

This saw-tooth roof may be used on the top of a monitor in place of side windows, and it results in a much better lighted floor.

Old shops, in which a change in amount or location of glass area is impossible, can have their light increased in amount and better distributed by a judicious arrangement of machines, and, particularly, by keeping the walls and ceilings as nearly pure white as possible.

WELSBACH LIGHT WITH SILVERED GLASS REFLECTOR. No. 314. Diameter, 10 inches.

Whitewash is so cheap and so easily applied by modern pneumatic methods, that there is little or no excuse for neglect in this particular. Whitewash can easily be made so that it will not readily rub off, in fact so that it can be washed; but in most cases a fresh application is preferable to cleaning. The removal of all possible belting (which can be accomplished by electric driving, either individually or by the group system) adds largely to the

OPEN-ARC LAMP, DOUBLE. Old Style.

OPEN-ARC LAMP, SINGLE. Old Style.

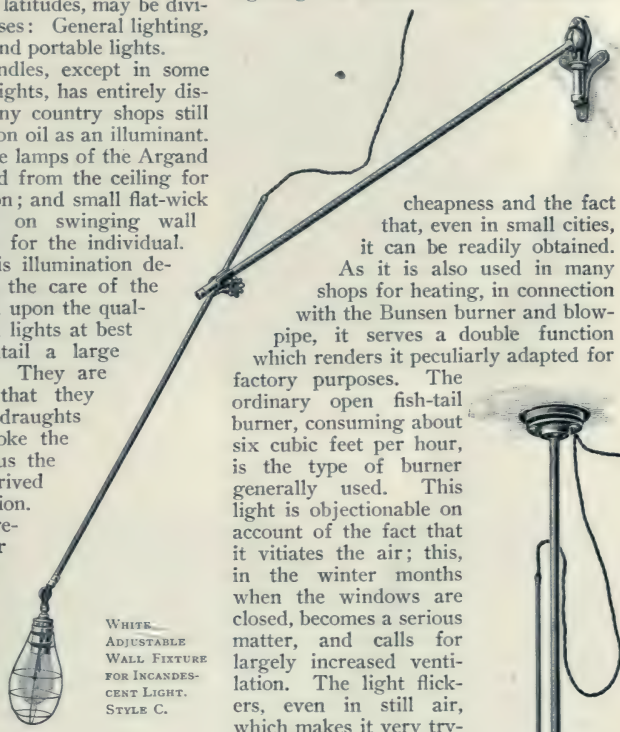
lighting effect, and also, by the suppression of dust and flying oil, keeps the walls and ceilings in much better condition. Some factories carry this whitening effect to the point of having the machine tools painted white and varnished. This not only avoids dark spots in the room, but shows plainly any neglect of machinery. In a shop equipped in this

manner, the dirty and slothful workman is entirely out of place, and he usually changes his habits or seeks some other shop where his natural conditions prevail.

Artificial Lighting

Artificial lighting, which is usually required in northern latitudes, may be divided into three classes: General lighting, individual lights, and portable lights.

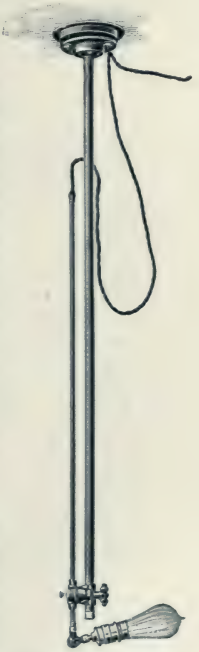
Lighting by candles, except in some cases of portable lights, has entirely disappeared; but many country shops still have to depend upon oil as an illuminant. In such cases, large lamps of the Argand type are suspended from the ceiling for general illumination; and small flat-wick lamps, preferably on swinging wall brackets, are used for the individual. The quality of this illumination depends, first, upon the care of the lamps, and second, upon the quality of the oil. Oil lights at best are dirty and entail a large amount of labor. They are objectionable in that they must be kept from draughts of air, which smoke the chimneys; and thus the shop is often deprived of proper ventilation.



White Adjustable Wall Fixture for Incandescent Light. Style C.

Gas is more frequently used for shop lighting than any other artificial illuminant. It may be classed under the heads of oil gas, coal gas, natural gas, and acetylene. For the isolated shop oil gas and acetylene are particularly adapted, as such gas plants are easily installed and require but little attention. In every case, the gas plant should be entirely separate from the factory building, and preferably underground. While acetylene furnishes a light almost ideal in character, it is particularly poisonous, although leakage is readily detected by its odor. A more serious drawback is that this gas forms violently explosive compounds when mixed with air in comparatively small proportions. Many serious and sometimes fatal accidents have occurred by failure to realize the importance of this fact. These installations should be made only by those thoroughly familiar with the subject, and their use must be carefully guarded.

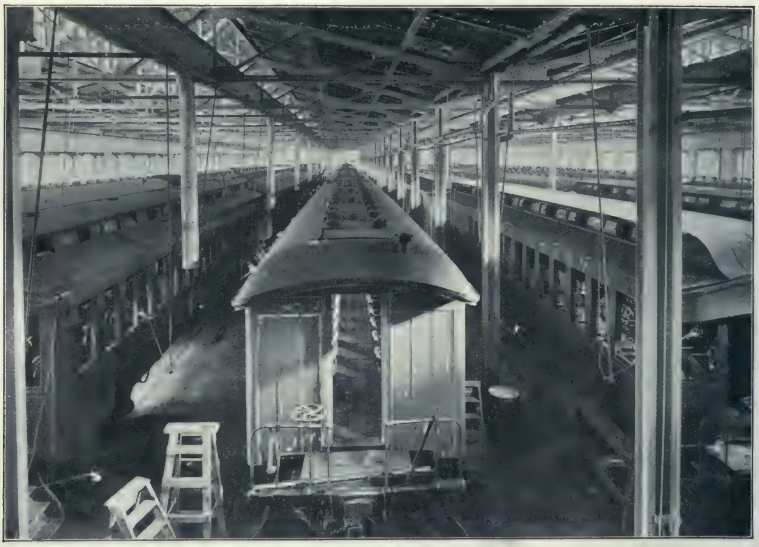
Coal gas is very largely used for shop lighting, on account of its comparative cheapness and the fact that, even in small cities, it can be readily obtained. As it is also used in many shops for heating, in connection with the Bunsen burner and blowpipe, it serves a double function which renders it peculiarly adapted for factory purposes. The ordinary open fish-tail burner, consuming about six cubic feet per hour, is the type of burner generally used. This light is objectionable on account of the fact that it vitiates the air; this, in the winter months when the windows are closed, becomes a serious matter, and calls for largely increased ventilation. The light flickers, even in still air, which makes it very trying to one's eyes when engaged on fine work; and this difficulty is further increased by currents of air caused by open windows or moving belts.



White Adjustable Ceiling Fixture for Incandescent Light. Style A.

The Welsbach Burner

Ordinary illuminating gas used in connection with a Welsbach burner, furnishes a very steady light with about one-half the gas consumption necessary for the



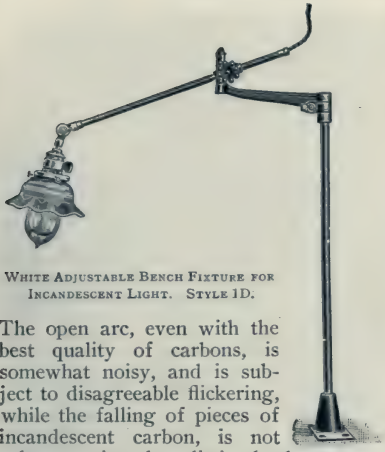
INTERIOR OF PAINT SHOP, BOSTON & ALBANY RAILROAD, ALLSTON, MASS.
Incandescent Lights Installed with White Adjustable Fixtures.

open light. The Welsbach light is best suited for general lighting, where two or more burners are contained in the same globe and suspended from the ceiling. As an individual light, the Welsbach is not in great favor, on account of its ghastly color combined with a faint tinge of green, which renders it objectionable to many workmen. The mantle used in the Welsbach light is extremely fragile; and it is quickly put out of commission by shocks, vibration, and air currents. For these reasons it is not so well suited for use in the shop as it is for domestic purposes. The Welsbach light, however, is not dependent upon the illuminating quality of the gas, but upon the incandescence of the mantle, which may be produced by any form of fuel gas without the enriching necessary to make it suitable for use in an open burner. Natural gas, therefore, which is used for heating in many sections of the country, can also be used for lighting if employed in the Welsbach burner. As this gas is very cheap, it often pays to use it in this manner.

COOPER HEWITT LAMP FOR INTERIOR LIGHTING WHERE ONLY MODERATELY STRONG ILLUMINATION IS DESIRED.
Designed for series installation—two in series on 100 to 120 volts direct current. Suspended at an angle of 20° from ceiling or fastened to wall. Type H 6.

Electric Lighting

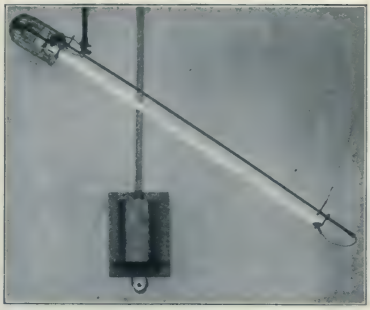
Electric lighting is rapidly being introduced for shop purposes, especially when the current is generated in the factory. The arc light is commonly used for general illumination, and the incandescent light for the individual. The open-arc light is being supplanted by the enclosed arc, with a distinct gain in economy and safety.



WHITE ADJUSTABLE BENCH FIXTURE FOR INCANDESCENT LIGHT. STYLE 1D.

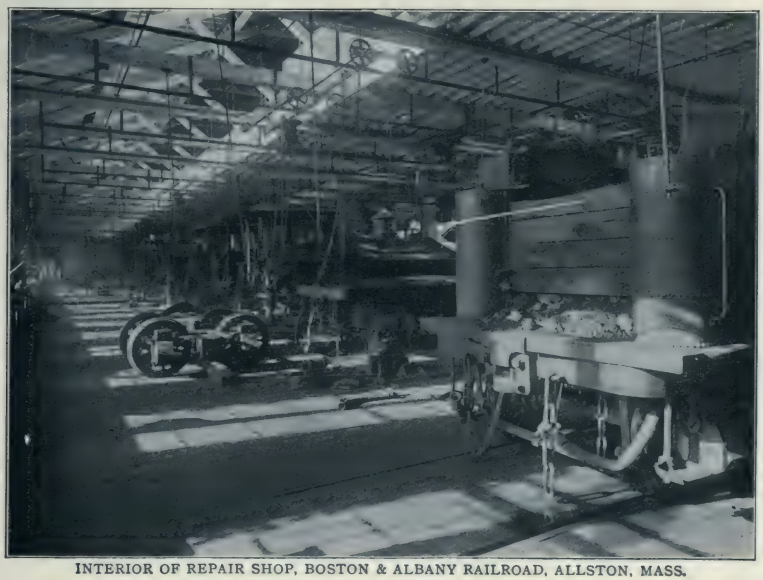
The open arc, even with the best quality of carbons, is somewhat noisy, and is subject to disagreeable flickering, while the falling of pieces of incandescent carbon, is not only annoying, but distinctly dangerous. The enclosed-arc light requires less frequent trimming, is more steady, and, owing to the fact that it is enclosed, it absolutely prevents danger from falling particles of carbon. Arc lights for general illumination are usually in the vicinity of 1,200 candle-power.

The 16-candle-power incandescent lamp is generally used for individual light; but the 8-candle-power lamp, with a suitable reflector, is less dazzling and furnishes all the light necessary. The system adopted in some drafting rooms, of using an inverted arc—that is, one with the crater in the lower carbon—combined with a reflector to throw the light directly to the ceiling, results in a very uniformly diffused light. This



COOPER HEWITT LAMP FOR INTERIOR LIGHTING WHERE STRONG ILLUMINATION IS DESIRED.

Suspended from ceiling at an angle of 30° to 90°. Cannot be operated in horizontal position. Designed to replace ordinary 5-ampere enclosed arc or cluster of incandescent lamps. Average life, 1,600 hours. Type V 5.



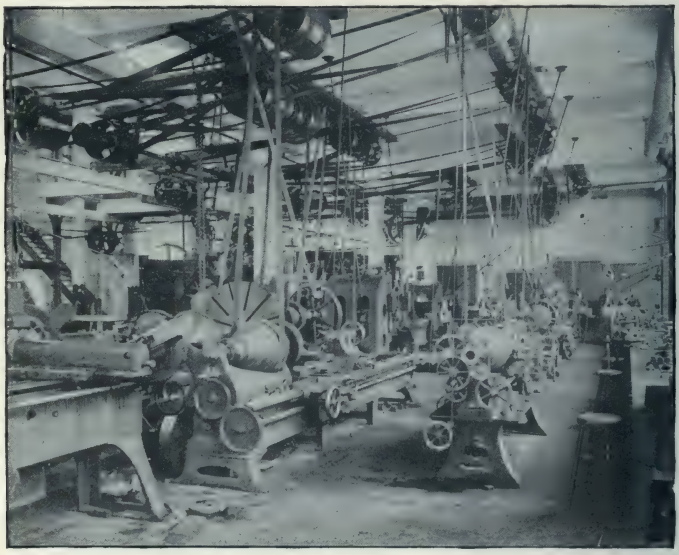
INTERIOR OF REPAIR SHOP, BOSTON & ALBANY RAILROAD, ALLSTON, MASS.

Incandescent Lights Installed with White Adjustable Fixtures.

WHITE ADJUSTABLE FIXTURES IN OFFICE OF WORCESTER SAFE DEPOSIT & TRUST COMPANY, WORCESTER, MASS.

avoids the sharp shadows cast by the direct light from the arc, and has much to recommend it as a shop light, especially if the ceilings and walls are kept white.

There are several styles of fixtures



BOSTON & ALBANY RAILROAD MACHINE SHOP, WEST SPRINGFIELD, MASS.
Equipped with White Adjustable Fixtures.

COOPER-HEWITT LAMP FOR GENERAL INTERIOR LIGHTING.
Type H 7, an improved form of Type V 5. Can be operated in horizontal, vertical, or inclined position.

used in connection with the incandescent light to place the lamp in any desired position, as the ordinary drop light is very inconvenient in this particular. The White fixture, with its ball-and-socket joint, is one of the best.

In connection with the question of electric lighting, the necessity of maintaining a constant voltage is one that is not given the attention it deserves. It is almost impossible to secure satisfactory lighting from a generator driven by the main engine; and this is especially true if electric cranes are also operated from this generator. In the best practice it is considered necessary to have a separate engine and generator to be used solely for the lighting system. A generator driven by the main engine is found satisfactory for crane service.

The Cooper Hewitt Light

The Cooper Hewitt mercury vapor lamp is the cheapest form of electric lighting, and will undoubtedly be heard from as a commercial light for factory use, especially in shops doing a fine class of work. The color of this light, due to

CORNER OF DRAFTING ROOM ILLUMINATED BY HEWITT LAMPS.

the total absence of red rays, is objectionable but not injurious; and further experiments will undoubtedly produce a light based on this principle which will meet many requirements.

For portable lighting, there is nothing at present superior to the incandescent lamp, for, by means of a long flexible cord, it can be taken to any position. The incandescent lamp, furnished with a magnetic base, can be attached to any iron or steel surface, where it will remain until the light is extinguished. For erection work, particularly, this type of lamp is peculiarly adapted, although it has not been very generally adopted. The current consumption to produce the magnetizing effect is quite small, and is more than offset by the convenience of the light.

The system of lighting to be adopted, it will be seen, depends on local conditions; but the efficiency of any system will be greatly increased by proper attention to the minor points above enumerated.

The Workman

THIS is the work of my hands:
To be but a cog in the wheel—
A strand in the cable that hauls—
To do and to do—not to feel.
To toil till the last curtain falls.
Yet ever the toiler is blest
Who sees the fair vision unroll—
Interprets the dream half-expressed—
Feels the work of his hands with his soul!

This is the work of my hands:
These monsters that furrow the deep
And baffle the power of the sea
Were given the sinews to leap,
Were bolted and forged by me.
These webs of miraculous steel,
Outspun from the shore to the shore,
My nerve and endurance reveal—
I rolled them, and wove them, and bore.

This is the work of my hands:
To drudge, but in spirit be free—
Eat bread by the sweat of my brow
In accord with the ancient decree—
Yet labor, with courage, endow;
To know that, though meager the gain
While justice shows many a flaw—
In spite of distrust and disdain
We are rising, and under the law.

This is the work of my hands:
To cherish the law of the land,
The shield that we've wrung from our foe;
Ennoble the rights we demand,
By the honor and faith we bestow.
For brother am I to all,
The helpless ones and the great;
Together we rise or we fall,
Free workers within a free state.

—Robert Bridges in *Collier's Weekly*.

The Automobile in War

Use of the Self-Propelled Vehicle in Military Operations—The Auto-Telegraph Car of the United States Signal Corps Tested at Bull Run

By ARTHUR MURCHISON
Special Correspondent

THE USE of the automobile in warfare may be said to be as yet in the experimental stage. Several of the European powers, notably France and Great Britain, have given some attention to the matter of the utilization of motor cars for military purposes. Their efforts have been mainly along the line of the provision of motor batteries, and it must be admitted that the mobility of light artillery has been greatly enhanced by the introduction of such propulsive power.

The War Department of the United States has been somewhat behind the corresponding branches of foreign nations in making practical demonstration of the availability of the horseless vehicles for military purposes, but has lately taken up the subject with an energy which augurs well for tangible achievement. At the annual military manœuvers of the United States Army, held at Manassas, Virginia, in September, 1904, several classes of military automobiles were subjected to the test of actual service in the field.

Several of the automobiles used at the manœuvers were touring cars of the ordinary type but of extra heavy construction, which were employed by the corps commanders as vehicles for personal conveyance in order to enable them to cover rapidly the great distances within the limits of the field of action. There was a heavy gasoline truck which partook of the character of a portable machine-shop for general repair work; and, finally, there was the new "auto-telegraph car," as it is designated, which has just been constructed for the Signal Corps of the Army.

This telegraph car not only is decidedly the most interesting war automobile which has been introduced in America, but it bids fair to prove of greater practical utility than any other military motor employed by any nation. Its use at the recent manœuvers and at the United States Signal Corps Post at Fort Myer, Virginia—where extensive trials have taken place—constitutes, indeed, the first practical demonstration of the use of the automobile in warfare.

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TELEGRAPHING IN THE FIELD.

The Auto-Telegraph Car

In general design the new auto-telegraph car conforms very closely to a standard high-power, long-distance, touring car of the Winton type, with the exception that, instead of the ordinary tonneau, this machine has a tonneau attachment of special design, more roomy than

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USE OF THE AUTOMOBILE IN WAR.—AUTO-TELEGRAPH CAR OF THE SIGNAL CORPS, U. S. ARMY.

A Scene during the Manœuvers of 1904 on the Historic Battlefield of Bull Run.

this apartment in the stereotyped style of machine, and with long seats extending along both sides, the occupants of which face one another. The seats for the driver of the automobile and his assistant are arranged in front on the approved plan in such machines.

It is, of course, essential that in a machine destined for such uses ample space shall be provided for the storage of instruments, wire, and other equipment; and to this end, spacious lockers have been provided under the seats and elsewhere in the body of the machine. Some idea of the quantity of material which can be transported, may be formed from the fact that the Signal Corps of the Army is now making use in its line work of a wire so light and fine that a reel of it may be carried in a man's pocket. At the sides of the auto-telegraph car are racks on which are carried considerable numbers of lances, or light poles, which may be employed in stringing a temporary overhead telephone or telegraph line when other supports for the wire are not available.

The functions of this new war automobile are somewhat varied. In the main, however, it is designated as an adjunct for what is now the chief work of the United States Signal Corps—namely, the construction, maintenance, and operation of temporary or permanent telephone or telegraph lines. Presumably its greatest usefulness will be found as a moving base of supplies in the erection of telephone or telegraph lines connecting a military post or other headquarters with a force in the field.

Heretofore it has been extremely difficult to keep pace in the erection of a communicative line with the march of a rapidly moving field force, and particularly has this been the case when, as frequently happens, the troops in the field are operating under orders which it is not deemed advisable to disclose until the hour of execution, thus precluding the possibility of advance work in establish-

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AUTO-TELEGRAPH CAR OF THE SIGNAL CORPS, U. S. ARMY.
Following the Troops and Taking New Position.

ing wire communication. With the new high-speed auto-telegraph car, however, a detachment of the Signal Corps engaged in line work will be enabled to keep pace with the most rapidly moving force of infantry or artillery, and could probably hold their own even with cavalry.

vices provided are improved "sounders," which render possible the receipt and transmission of messages without regard alike to the roar of artillery or the eavesdropping of spies loitering near the car to overhear communications.

The detachment of Signal Corps men comprising the auto squad for the new

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A LULL IN THE OPERATIONS.

War Automobile and Squad of the Signal Corps, U. S. Army, at Manœuvers on the Field of Bull Run.

Fully as important as the functions of the auto-car for line-construction work, is its adaptability for use as a portable or field telegraph and telephone station. The car is fully equipped with receiving and transmitting instruments, and can be brought to a standstill at any point during the erection of a line or where a wire system already exists, and communication instantly opened with the terminus of the line or any intermediate point. Great care has been exercised in the selection of the equipment of this "flying" telegraph office; and among the de-

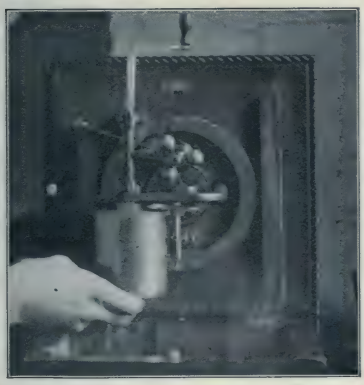
car, comprises eight or nine men. In addition to the operator of the machine, there are one or two telegraph and telephone operators; and the remainder of the squad, while capable of doing service as linemen, are attached to the car principally as an armed guard for the operators above mentioned. The latter are also, of course, fully armed and capable of taking care of themselves in a brush with the enemy. The auto squad is now being perfected in a regular drill as distinctive in character as that of the Artillery or any other branch of the Army.

Making a Talking Machine

An Observation Trip through One of the Great Factories where Phonographs are Made

By DAY ALLEN WILLEY

ONLY A FEW YEARS ago did we begin to hear the talking machine—or "phonograph," as some call it; but now this marvel of mechanical ingenuity is in such common use that it has become quite as familiar as the piano. Like the latter, it has been so improved that the modern



Clockwork Motor That Operates the Talking Machine.

talking machine is as different from the ones first made, as the piano is different from the old-time harpsichord.

Examine a talking machine, and it appears merely to be composed of a horn mounted on a polished wooden pedestal, with a few pieces of mechanism attached which are so small as to be insignificant in appearance. If you were to go through a factory where these machines are made, however, you would soon realize how important are the smallest parts. The horn is attached to an elbow which swings in any direction so that the sound can be thrown into any part of the hall or room. The pedestal is really a box in which is placed the motor. While tiny electric motors are sometimes used, a popular type of machine is operated by a spring like the motor of an ordinary clock. The use of the motor is merely to revolve an iron "turntable" situated on the top of the pedestal, with which it is connected by a pin or vertical axle joined to the bottom of the turntable. Really, the motor has, in itself, absolutely nothing to do with the sound production. On the turntable rests the "record"—the musical composition or other subject to be mechanically reproduced. By merely pressing a button or pushing a lever, the motor is started, and the turntable, with the record upon it, begins revolving. The contact of the sound needle with the sur-

Finishing an Elbow for the Horn by Machinery.

ASSEMBLING THE MOTORS.
Showing one of the 12-foot springs unwound.

face of the moving record creates the sound waves—"makes the noise."

One company in Camden, New Jersey, manufactures no less than 200,000 machines annually, and requires several large buildings. To begin at the top of each building and go through it all, the visitor is astonished to see the hundred processes which must be utilized; and he marvels at the way in which metal, wood, and mica, can be made into devices that reproduce talk, laughter, and song so human-like that it is startling. If you have a mechanical bent, you will pause to watch the drills which bore holes through the pieces of brass and steel required for many of the parts, as easily as if cutting through paper. There are scores of lathes, also grinding and polishing wheels. As the talking machine goes into many a parlor, and can be attractive as an ornament as well as a thing of use, some parts of it are heavily nickeled in the plating department. The elbow on which the horn rests, and the arm supporting it, are some of the parts ornamented. A dozen men are kept busy around the plating tanks alone.

PLACING THE MICA DISCS IN THE SOUND BOX.

The Motor

On another floor the motors are put together. As the cog-wheels, pinions, and governing balls are fitted to one another and attached to the spring, this part of the machine seems strong enough to pull a street-car. The spring measures 12 feet in length, and is of steel of such fine temper that it can be wound into a space two or three inches square without breaking. But the whole "movement" is so tightly shut in the case on which the horn rests that it is dust-proof. It is so

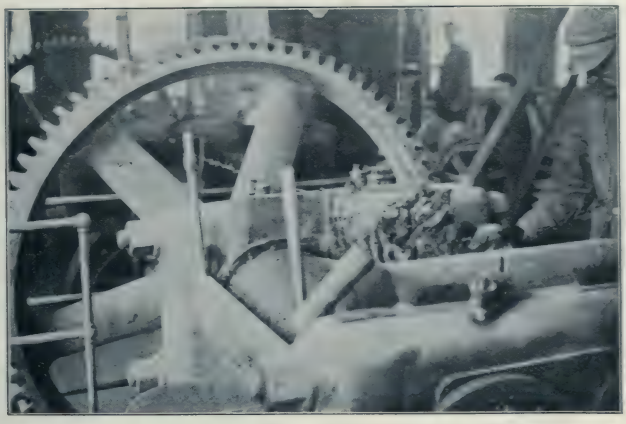
ADJUSTING THE SOUND NEEDLE TO THE SOUND BOX.
The most important work in making talking machines.

powerful that it will play the piano or lead the band for you for twenty minutes at a time, before it is necessary to wind it as we do the clock.

The Sound Box

Now we come to one of the wonderful parts of the machine — the part which transmits the sound from the record to the horn. It can be held in the palm of the hand, and some of its pieces can scarcely be seen without a magnifying glass, yet it requires greater skill to create each piece and to fit the parts together in the right way than does the construction of any other portion of the machine. What you probably notice first is a piece of mica from India, a little over an inch in diameter. The company buys about thirty tons of this mineral every year, so much is rejected in getting sheets of the proper quality. Expert

sorters go over the pile, and pick out a piece here and there until they have found what they want. Then the pile which has been picked out is culled over again and again, split into thinner sheets, measured with tiny gauges, looked through, felt with the fingers, and more and more constantly thrown out.



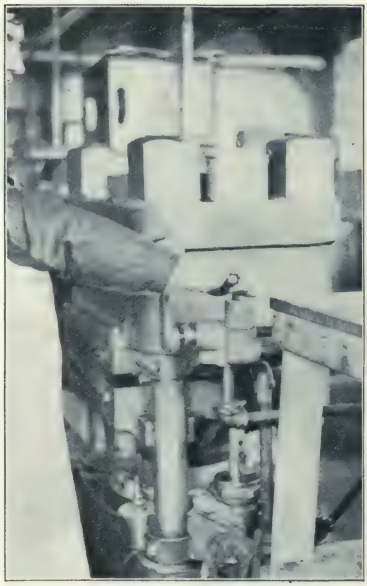
FIRST STEP IN RECORD MAKING.—ROLLING THE COMPOUND INTO A MAT.

Mica is to the talking machine what the diaphragm is to the mouthpiece of the telephone. It sends the sound waves to the horn by its vibration, and on this vibratory quality much depends. It is so strong that some of the little discs are actually only about one five-thousandth of an inch in thickness, yet they last for years. So sensitive is the disc that if you merely lay a finger tip on one while the machine is playing, you can feel it quiver and throb as if filled with life. It must be carefully protected, and accordingly is clamped into a metal ring composed of two halves, each of which is lined with rubber gaskets to hold its edges firmly.

Deft and light fingers are needed in finishing the "sound boxes"; but besides the mica disc and its frame, there are other pieces of mechanism in them just as necessary. For instance, a sliver of steel must be fastened to the center of the disc by a drop of shellac—a sort of needle curved at the upper end so as to touch the mica. The lower end sets in a steel socket, the sound-box "arm." Thus a miniature telephone line is built between the horn and the record. Two more pieces complete the sound box—the record needle, and the sound-box holder which joins it to the elbow of the horn. The record needle fits into the same steel socket that holds the other needle, but projects downward instead of upward, its point resting on the record. It looks like a small sewing machine needle without any eye, and is held in place by a simple thumbscrew in the same way, so that it can be taken out and replaced in a few seconds.

The notes from the record pass from

PLACING MAT UPON MATRIX THAT CONTAINS CHARACTERS REPRESENTING THE SONG OR TALK.



PRESSING THE MAT BY HYDRAULIC POWER.

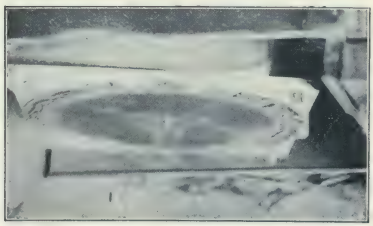
the record needle to the sound needle in the form of vibrations or waves. Every one is transmitted to the mica, which broadens them out or magnifies them, and sends them on into the horn. Then they expand as the bell of the horn opens out, until they reach the ear. The music is thus telephoned, one might say, by the sound box, from the record to the horn.

The Record

But perhaps the most curious part of it all is that round, black plate which looks like gutta-percha. It seems like magic, yet when the clockwork motor is started and it whirls round and round the needle point, you hear the full, rich tones. Lift the needle from it a fraction of an inch, and the sound ceases instantly.

In one of the rooms of the factory are piles of what appear to be powdered dirt and barrels of shellac, from which the records are made. A workman scoops up a lot of one kind of powder, dumps it into a bin with some of the other kinds, mixing it together until it becomes a dirty yellow mass. On one side of the room stands a row of ponderous machines, each containing two rolls. Each roll is hollowed out to allow a steam pipe to be placed in it, so that it can be heated. Pouring the yellowish powder between the rolls, the workman adds the shellac, which quickly melts in the heat, and mixes with the powder, forming a kind of dough. This adheres to the revolving rolls in folds, which become thicker and thicker. After a few minutes of this sort of work, a batch is "done" and ready to be rolled out. The material is lifted from the mixer in folds like cotton batting. It has been made into a sort of fabric, held together by the melted shellac. While it is still hot from the press, the workman feeds it into another machine with two smaller rolls, which are closer together. When these revolve, a double-bladed knife also revolves, and, as the mat is pressed out upon the long table, cuts it into sections a foot or so in length. This is the form in which it goes to the record maker.

A GLIMPSE IN THE RECORD LIBRARY, SHOWING LECTURES, SONGS, AND INSTRUMENTAL MUSIC READY FOR SHIPMENT.



THE RECORD AS IT LOOKS AFTER BEING PRESSED.

Now we come to one of the most interesting departments. Rows of men stand in front of steel slabs almost too hot for you to touch with your finger.

THE FINISHED RECORD.

A workman, taking up a square or mat of the record composition, places it upon the steel mould; then, picking up a round sheet of what appears to be silver or steel, puts a lettered label over the pin in its center and presses it into the mould over the mat. Grasping the mould with both hands—for it is quite heavy—he shoves it into the hydraulic press back of him, and, pulling a little handle, releases a weight of no less than 100 tons, which presses upon the mat. When the mat is taken out, it looks like hard rubber and has indelibly moulded upon it the lines of the song, story, or music transferred from the metal disc which is the matrix. If the disc or the record is carefully examined with a powerful magnifying glass, the lines, which are cut into its face, apparently in circles gradually narrowing as they approach the center, will be found to be more or less serrated—each composed of a series of tiny angles and curves of irregular size. These formations are faithful reproductions of the sound waves, the broader and deeper ones corresponding to the louder tones, the smaller ones to the staccato notes, etc. Although the lines run round and round, they never cross. They form a coil like a watch spring. When the record needle reads the music or begins to tell the story of the comedian, it starts on the very edge of the record, going into every one of the curves and angles until it reaches the center. There it has to stop as this is the end of the composition.

Over 25,000 records are often made in a day at the factory mentioned, but all are finished in this building. In all, there are forty presses, although some exert a weight of but sixty tons, for the records are made in different sizes, some as large as 14 inches in diameter. It is surprising how light the record discs are, but they are tough as well as light. You might stand two or three of them on edge, put a board on them, and sit on the board, without breaking them. Consequently they can easily be packed and sent to any part of the world.

Upon the top floor of one of the buildings is a musical library, which is perhaps the greatest of its kind in the world, for here are boxes containing over 1,000,000 records, yet so carefully classified and indexed that the librarian can pick out the "Sextet from Florodora," or

LAST STEP IN MAKING THE TALKING MACHINE. Testing the motion of the turntable by the ear, to see if it runs noiselessly and smoothly.

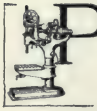
a rag-time melody, and have it packed and on its way to the one who wants it, within fifteen minutes after the telegram

is received. For the talking machine, Tamagno has rendered scenes from "Othello," "Il Trovatore," and "Guillaume Tell." Caruso is heard in "Aida," in "Cavalleria Rusticana," and in "Tosca," the musical version of Sardou's famous drama. One listens to Calvé in "Carmen," and the romanza of Santuzza in "Cavalleria Rusticana." The deep tones of Plançon's basso are wonderfully brought out in "Faust" and "Le Cid." Scotti, Suzanne Adams, Delmas, Giraldoni, De Lucia, Ackté, Zélie de Lussan, and Campanari are other singers, known the world over, whose voices have been preserved in the renditions that have given them their fame. The master touch of Kubelik is repeated on the violin, and one laughs at the wit of the leading mirth-makers of their time. Truly, many of the records will be treasures to be preserved; and, thanks to the machine, they can be heard long after the singers themselves have uttered their last note.

Great American Technical Schools

Purdue University, Lafayette, Indiana

By FRITZ B. ERNST, B. S.
Instructor in Car and Locomotive Design



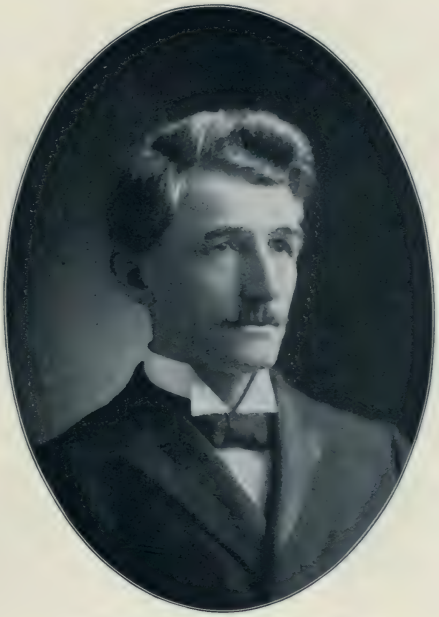
PURDUE UNIVERSITY is the State Institute of Technology of Indiana. It was organized under Act of Congress of July 2, 1862, which act apportioned public lands to the various States for the maintenance of colleges for instruction principally in lines relating to agriculture and the mechanical arts.

The name Purdue University was given the institution by the State Legislature in 1869, in consideration of a substantial gift of funds and land by John Purdue; and in the same year, Tippecanoe County was chosen as the permanent site—where the institution now stands, just without the corporation limits of the city of Lafayette. This city is a place of about 30,000 inhabitants,

ELIZA FOWLER HALL.
Containing Auditorium.

situated 120 miles southeast of Chicago and 65 miles north of Indianapolis, and has the transportation facilities of one electric and four steam railways. The institution, while bearing the name of Purdue, is exclusively under State control, with government aid, as provided in various Acts of Congress for the maintenance of the institution.

It is the purpose of the school—which is coeducational in its scope—to afford to young men and young women an opportunity of securing a general education in mathematics, science, literature, and art, with such specialized practical training in the shop and laboratory as will fit them to engage in the practical industries. Being a State institution, instruction is free to students of Indiana, while a small tuition fee is charged those from without the State.



WINTHROP ELLSWORTH STONE, PH. D.
President, Purdue University.

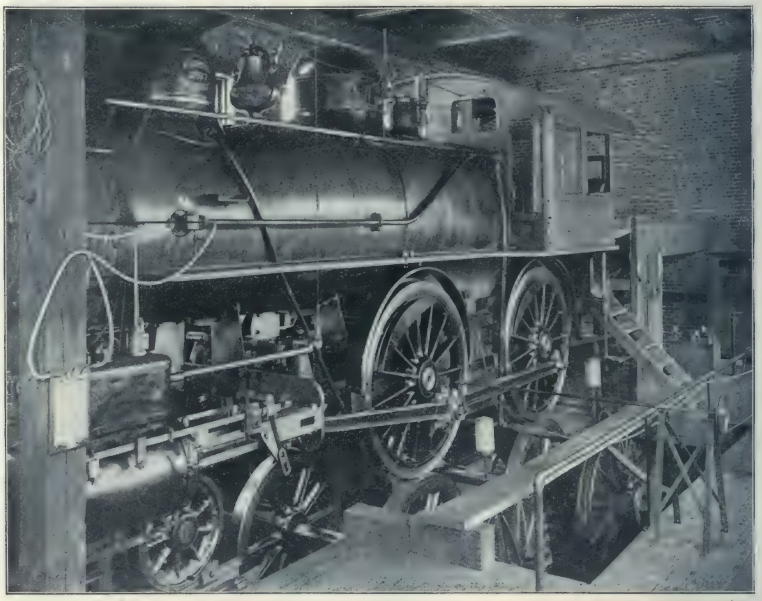
Special Schools of Engineering

The University embraces six special schools, as follows: Mechanical Engineering, Electrical Engineering, Civil Engineering, Agriculture, Science, and Pharmacy—these schools all leading to the degree of Bachelor of Science. In the first five schools mentioned, with few exceptions, there is included the same instruction in general science, mathematics, language, literature, history, political science, and industrial drawing. In addition to these branches, each school includes in the four years its special shop, field, and laboratory practice in the line in which the student is specializing.

Mechanical Engineering Course

In the course in Mechanical Engineering, as in the other engineering courses, the first two years are given over largely to general studies, the textbooks being principally those in pure mathematics, languages, literature, etc., and the shop training consists of work in the wood room, the foundry, and the machine and forge shops. With this training as a basis, the Junior and Senior years are devoted to the study of such applied branches as Mechanics, Hydraulics, Thermodynamics, Stresses, etc., while the practical work consists of full time in the drafting room and the laboratories.

During the Junior year, the entire time in the drafting room is taken up with Machine Design, in which the student designs those machines wherein are embodied the greatest variety of problems that he is likely to encounter in practical work. In the Senior year, the student is allowed to specialize in his design work by an option between Car Design and Steam Engine Design during the first semester, and between General Engineering Design and Locomotive Design during the second semester. As illustrative of the work in design—the class in Car Design, for example, is divided into groups of from two to four students, each group choosing some type of car to be built complete from the rails up. Methods of design are first given in the class-room, after which the work is proportioned among the members of the different groups, each man working out in detail his part. The truck is finished before the body of the car is taken up; and when all of its parts have been designed, each member of the group is required to make an assembled view, so that he gains a knowledge of those parts which were designed in detail by other members of the party. In the same way, the car bodies are taken up; and at the end, complete assembled views of the individual cars are made by every member of the class.



"SCHENECTADY NO. 2," LOCOMOTIVE LABORATORY, PURDUE UNIVERSITY.

ENGINEERING BUILDING.
Occupied by Departments of Civil and Mechanical Engineering. Built of brick and stone.
Frontage, 388 feet. Depth, 234 feet.

ELECTRICAL BUILDING.
Devoted to the Department of Electrical Engineering.

LOCATION PARTY, CIVIL ENGINEERING.

Meanwhile, in the Steam Engineering Laboratory, the student is conducting experiments on various types of engines, turbines, pumps, etc.; and in the Locomotive Laboratory, similar work is in progress on "Schenectady No. 2." as the locomotive testing plant is named. Likewise, in the Laboratory for Testing Materials, the strength of different materials in tension, compression, torsion, impact, etc., is being investigated.

The Locomotive Laboratory

Probably the best known feature of the mechanical equipment of Purdue is the locomotive testing plant designed by W. F. M. Goss, Dean of the Schools of Engineering. The plant includes an American-type locomotive weighing 107,000 pounds, known as "Schenectady No. 2," mounted on supporting wheels carried by shafts, the latter running in fixed bearings and turning with the drivers

DRAFTING ROOM, SENIOR DESIGN.

TRIANGULATING ACROSS WABASH RIVER.

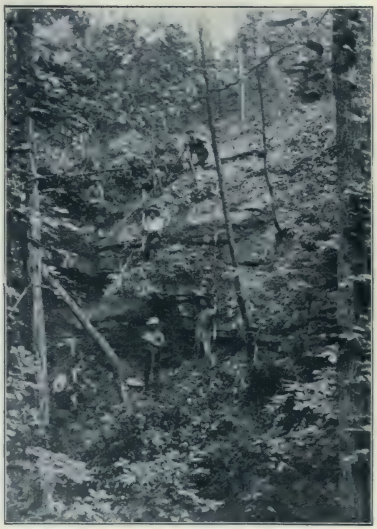
of the engines. On these shafts are also provided brakes with a capacity sufficient to absorb the maximum power of the engine, a traction dynamometer indicating the tractive effort. Thus mounted, the action of the engine can be studied and its performance tested while it is run at any desired speed and under any load, the conditions being similar to those on the road.

Besides the above-mentioned equipment, excellent opportunity is afforded for testing and experimental work on apparatus deposited with the University by the Master Car-Builders' Association, including a brake-shoe testing machine, on which all of the brake-shoe experiments of the Association are conducted; an air-brake testing rack, consisting of a rack on which is mounted a complete air-brake equipment for a train of 100 freight cars; and a drop-testing machine for testing couplers, draft riggings, car axles, rails, etc.

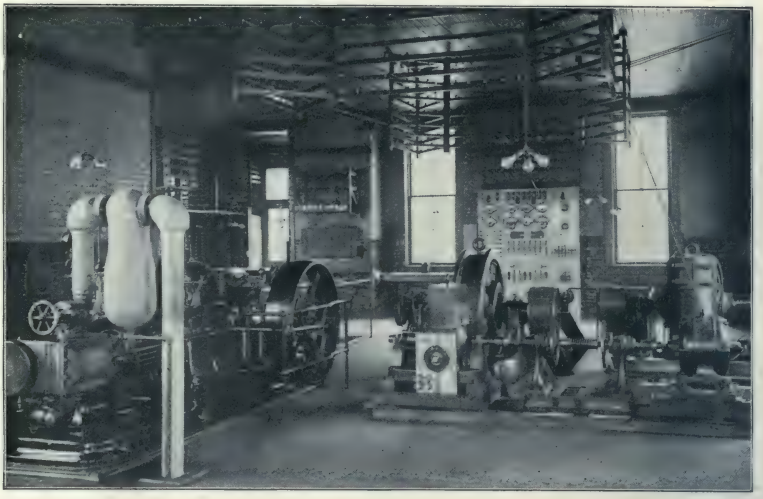
For further reference work in Railway Engineering lines, there have been deposited in the Locomotive Museum one English and two American locomotives, together with a wooden model of an historical engine, and a varied equipment of car bolsters, boxes, couplers, trucks, etc.

It is purposed in the Course in Mechanical Engineering to prepare the student for the active engineering field in mechanical lines. Accordingly the students, upon graduation, are found in the railway service, shops, and manufacturing and power plants, and with steam and gas engine companies, heating and ventilating concerns, and others engaged in individual manufacturing enterprises.

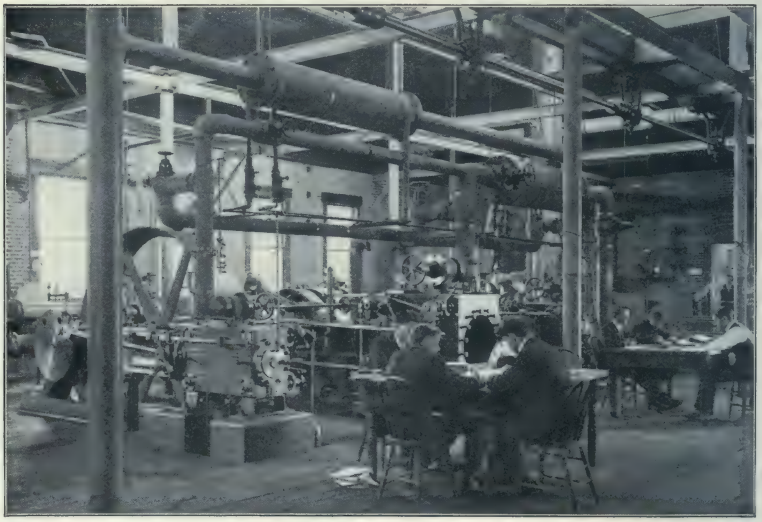
The thesis work of students in this department consists in the design of engines, power and heating plants, and railway cars and equipment; tests of various steam and gas engines and municipal plants; determination of the strength of various materials; together with a large amount of experimental work on "Schenectady No. 2."



SUMMER WORK AT SURVEYING.



PART OF DYNAMO ROOM.
A Corner in one of the Large Laboratories of the Department of Electrical Engineering.
Located in the Electrical Building.



STEAM ENGINEERING LABORATORY.
Located in the Engineering Building, Department of Mechanical Engineering.
Showing a small portion of Purdue's magnificent equipment.

Electrical Engineering Course

The School of Electrical Engineering occupies a three-story structure of dressed stone and brick, located about the center of the campus.

In the Department of Electrical Engineering there are at present some 404 students enrolled.

The course in Electrical Engineering is designed to give the student the theoretical and practical training which will enable him to find employment in any branch of the Electrical industry. Graduates of the department may now be found in the employment of lighting and power companies, interurban and street railways, the engineering and construction departments of electrical manufactories, as managers and superintendents of municipal and isolated lighting plants, instructors in technical institutions, and in various departments of the telephone engineering field.

In connection with thesis work, considerable original research is conducted, and much important information has been obtained through the medium of such work on the part of students and instructors.

Civil Engineering Course

The varied and responsible positions held by the graduates of the Department of Civil Engineering, are evidence of the thoroughly practical and efficient course administered by this department.

The theoretical training in the course embodies the broad general principles necessary to the successful professional career; and the applications are drawn from the best current engineering practice, with a view to giving the student the widest possible familiarity with the actual conditions to be expected in his own future practice.

TESTING DIRECT-CURRENT MOTORS.
Students at Work in one of the Numerous Laboratories in the Electrical Building.

The School of Civil Engineering was inaugurated at Purdue University about 1886, the first graduating class dating from the academic year 1887-88. The enrollment fluctuated more or less, gradually increasing until it reached 87 in 1898-99, after which there was a marked increase in the rate of growth. In March, 1904, the enrollment of Civil Engineering students was 306—an increase of 250 per cent in the five-year period since 1898-99. At the present time, the number of students in the Purdue School of Civil Engineering is within six of that at Cornell University, where the enrollment in this course is greater than at any other American technical school.

Within recent years, the Civil Engineering course at Purdue has been extended considerably in various directions —notably in railway lines—in which most important work has been accomplished.

The curriculum includes such culture subjects as English Literature, German, History, etc. in the first two years, and Economics in the Senior year. In addition to the course of Mathematics studied in the first three years, the sciences given include Physics in the Sophomore year, Chemistry in the Junior year, and Geology in the Senior year. Throughout the course an effort is made to train the student to proficiency in the routine work of his specialty; accuracy and self-reliance are constantly encouraged. Evidence of this training is well shown by the experience of many of the under-class students during their vacation employment in actual engineering work. In one of the accompanying illustrations is shown a party of Sophomore students generaled by a Junior during the summer of 1903, engaged on a complete topographical and general survey of a tract of some 2,000 acres for the State Board of Forestry for Indiana.

Field Work

The class work is arranged to present the theoretical aspects of the various subjects in a complete and vigorous way, and at the same time the field work and class exercises are based, as far as possible, upon actual engineering problems. For example, within the last two years, the Sophomore class work has included the surveys for the location, grading, ballasting, etc., of a four-mile electric railway line from the City of Lafayette to the State Soldiers' Home; the location and construction of a macadam park driveway and electric railway roadbed from the Wabash river road up to the Soldiers' Home (costing $15,000); the survey and establishment of a large cemetery, etc. The class in Railway Location and Construction has recently been engaged in making location surveys and estimates for a six-mile through-freight cut-off line for the Lake Erie & Western and the Cleveland, Cincinnati, Chicago & St. Louis Railways, with a view to eliminating a pusher grade at Lafayette.

The equipment available for field work includes all makes and types of instruments in general use.

Buildings and Grounds

The University is laid out on gently rolling ground, there being some 40 acres in the campus proper, and 180 acres in the campus and farm combined. The location is unusually healthful, the campus being on high, open ground just back of the steep hills bordering the Wabash river, and 114 feet above the latter.

To the late President James H. Smart, much credit is due for untiring efforts in behalf of Purdue; and to him, to his able successor, Dr. W. E. Stone, the present head of Purdue, and to Dean W. F. M. Goss, is largely due the marked growth which the University has experienced in late years, the enrollment last year numbering 1,433.

Greatest Stone Arch in America

An Engineering Feat of Unique Historical Interest

By GUY ELLIOTT MITCHELL
Secretary, National Irrigation Association

HE LIVED in a little cabin, alone and grim. He hunted, he fished. He spoke to but few, and none knew his name, till he came to be spoken of as "Cabin John." So say some old characters in Washington who have lived to see the city grow from a straggling town of dirty streets, puddles and ponds, and stagnant canals, to an imperial city of magnificent residences and broad, perfectly paved streets, and who remember the construction of the famous Cabin John bridge over forty years ago.

The question of a city water supply for the national capital early presented itself to the government engineers. Washington itself is at tide water; and since only the waters of the Potomac were available, it was seen to be necessary to go some distance above the city to secure an unpolluted supply. Such an opportunity was found some miles to the westward of the city, and the work of constructing the big conduit necessary began. Then came the problem of crossing a great gorge some 160 feet deep and over 350 feet wide, at the bottom of which flashed in the sunlight Cabin John creek; and as the structure progressed, it received the name of Cabin John bridge.

The original plans contemplated a bridge of six arches, each of 60-foot span. The piers were to be seven feet thick. The present great single-span bridge was the suggestion of Alfred L. Rives in 1857, then employed as an assistant to Captain Montgomery Meigs on the work of the National Capitol extension. Shortly afterward, Engineer Rives was appointed construction engineer of that section of the conduit work, under Captain Meigs. The site of the old fisherman's cabin was a short distance from and overlooking the sweeping Potomac river and the Chesapeake and Ohio canal, one of the first large results of General Washington's policy of internal improvement through national appropriations. In order to lessen the cost of transportation of material to the bridge site, a crib dam was thrown across Cabin John creek near its intersection with the canal, thus providing sufficient depth of water to allow the canal boats to bring their loads of rock and other building material up the canal and into the creek, to the position designed for the bridge. The work progressed with considerable celerity. Commencing in 1857, it was suspended in 1861, resumed the following year under the Interior Department, and was completed in 1864.

Ill-feeling arose between Secretary of War Floyd and Captain (later General) Meigs, owing to the latter's refusal to appoint a man on the work, recommended by Secretary Floyd, whom Captain Meigs deemed unfit for the position. As a result of this, Captain Meigs was superseded by Captain (later General) Benham in charge of the work. Captain Meigs, however, was to furnish the plans and estimates and to visit the work in order to see that they were carried out. Upon the appointment of the objectionable person, Captain Meigs informed the Comptroller of the Treasury that the estimates did not include this man's salary. This continued obstinacy drew upon Meigs the further wrath of Secretary Floyd, and he was ordered to the Dry Tortugas, being succeeded by Lieutenant Charles St. Clair Morton. Before leaving the work as chief engineer, however, Captain Meigs had caused his name as such to be cut on one of the ring stones of the bridge. Early in 1861, Lieutenant Morton caused his own name and that of

CABIN JOHN BRIDGE, THE LONGEST STONE ARCH IN AMERICA.

Located at one of the beauty spots in the vicinity of Washington, D. C.—Through the conduit enclosed by this bridge passes all the water supply of the national capital.

Captain Benham to be cut on other ring stones, as the bridge engineers. When Secretary Floyd resigned in 1861, Captain Meigs was immediately recalled and again placed in charge of the work; and but a few days later, two of the ring stones of Cabin John bridge had blank panels in their heads.

It has frequently been stated that the name of Jefferson Davis, as Secretary of War, was chipped out of a panel in the bridge, following his secession and elevation to the Presidency of the Confederacy, but this statement has been denied. There is no official account of such a proceeding; nevertheless it is a fact that the panel which originally had chiseled across its face the name of the War Secretary, is to-day a blank plane, sunken a little below the surrounding stone.

It is the proud boast of most Washingtonians, that they have in Cabin John bridge, with its imposing 220-foot single span, the longest stone arch in the world. This boast was well founded at the time of the construction of the bridge, and endured for years; but according to *Le Génie Civil* (October 4, 1903) there are two longer stone arches in the world, though Cabin John stands imperial in the United States. These longer arches are the Luxembourg bridge, built in 1899-1903, with a span of 275 feet; and the Marbegno bridge, recently completed over the River Adda in Italy, with a span of 236 feet. There was a bridge at Trezzo, over the same river, with a longer arch than the Marbegno bridge, but this was destroyed. So that, according to *Le Génie Civil,* Cabin John bridge now ranks third among the world's longest single-span stone bridges.

The arch stones in Cabin John bridge are four feet deep at the crown, and six feet at the impost. The curve is a segment of 110 degrees; the radius of the soffit is 134.28 feet; the rise is 57.26 feet. Since the completion of the bridge, all the city water supply for Washington has flowed through the conduit enclosed by it.

Were old Cabin John to return to earth, he would scarce recognize the site of his humble cabin. The surrounding grounds have been beautified; electric cars run to the bridge; and it is now one of the chief pleasure resorts of Washington, some eight miles from the city.

George Frisbie Hoar

Statesman, Scholar, Patriot

A Tribute

By Frank W. Gunsaulus, President, Armour Institute of Technology

THERE are several aspects of statesmanship, which our own American Republic will impress upon all realizing nationalities in all time to come. Our enterprise of self-government was conceived under the operation of the ideas of liberty and law, which took a long time for formal statement, but which rose at last into a song-like proclamation of Independence and Dependence:—the Declaration of Independence, the voice of liberty; and the Constitution of the United States, the voice of dependence upon law. No statesman of recent times has more completely uttered the full meaning of the gospel of human progress under government, and hence the true relationship of liberty and law, than the late Senator from Massachusetts—George Frisbie Hoar.

Physically his race is run. He has fulfilled his mission, leaving only a living principle and the inspiration of his personal character, his kind and generous nature, and his untiring labors for our nation's welfare and progress.

In his public career he manifested and illustrated in large measure the capacity of our public institutions to inspire, foster, and develop true greatness and genuineness of character. In his early career as a legislator, he was a prophet of technical education; and he stood upon these foundation principles while he pleaded for the modern school of technology with its consequent issues in industrial and agricultural education.

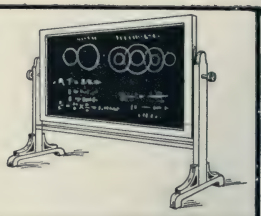
Senator Hoar was a profound and receptive student of history. Having in his veins the blood of Roger Sherman and that of other ancestors of the highest intellectual type, he had prophetic power because he had intellectual retrospect. I have often heard him quote George Eliot to the effect that "Our finest hope is finest memory." He not only revered the achievements of the past, but he interpreted the manner of their coming and the spirit in which they were generated. Taking up, for example, the

theme of human progress, he read the teachings of the past so accurately that he became a champion of that sort of education which will make the American free in the presence of great natural forces and opportunities, by making him the obedient servant of natural laws. He saw that the State could not afford to have orators and journalists prating about liberty and the greatness of America, if the American was not to be educated in his hands as well as in his head and in his heart. He saw that mere skill inherited from industrious ancestors, and mere facilities springing from a happy combination of faculties, would in no case afford a permanent foundation for the successful Americanism which he defended. This great continent appeared to him as an armory of tremendous forces; and the education which gave men a key to the armory and a knowledge of the use of these forces, was, to his mind a matter of patriotic necessity.

On that morning which we shall never forget at Armour Institute of Technology, when President Eliot of Harvard University and Senator Hoar got their first glimpse into certain phases of technical education in the Central West, and especially into the results of our Correspondence Instruction, the Senator had bought an old copy of "Martial's Epigrams." His talk was redolent of the fields where hum the bees of Theocritus. He was full of reminiscences of his early Harvard days, and eloquent with prophecy as to the future of American culture. We possess in the Institute's archives, the outline of his memorable speech to the thousand or more young men to whom he was introduced as "the legislative father of technical education in America." He gave us a swift and interesting talk on the early opposition to, and the rapid growth of, technical education. Rarely have we heard an old man in whose thoughts and sentiments there bubbled so musically the springs of eternal youth. It reminded one of Gladstone, who never seemed so young as when under the spell of the perennially fresh and ageless ideas of life. Senator Hoar's speech was a bugle call to righteousness of conduct, which the technical student realizes is the basis of all professional honor and fame.

In his death the nation has lost one of its ablest, most ardent, and most devoted patriots of recent years. We can best honor him by emulating his example and continuing to labor for those principles which he represented and upheld.

CHALK TALKS



by CARL S. DOW.

Number Nine—Refrigeration

The Ammonia Compression System

WE are all familiar with the cooling of various substances by placing them in contact with a colder body. We have examples of this in the family ice-box and the ice-cream freezer. There is nothing mysterious about this process, as we know that the ice is much cooler than the cream within the freezer, or the food within the ice-box. However, to many people it is a great mystery how ice is made and how rooms are cooled by using machinery every part of which is at normal temperature before the wheels begin to turn.

A Familiar Process

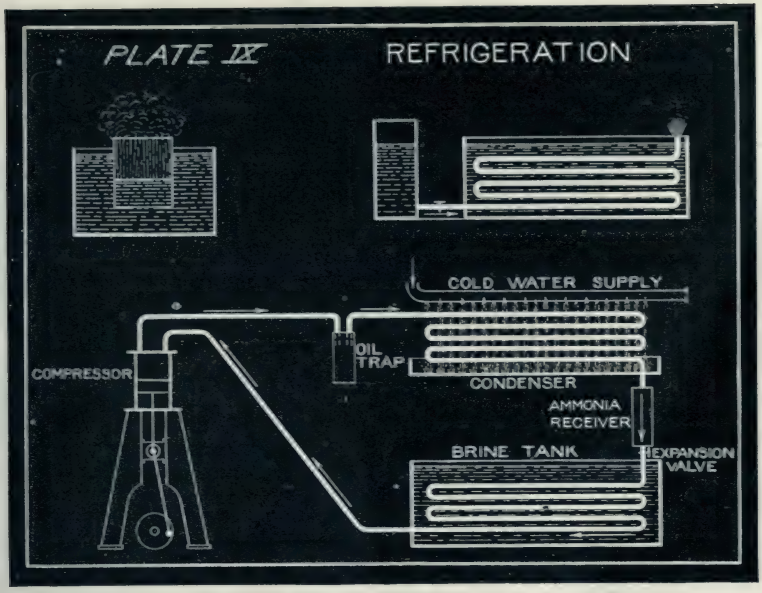
We know that the water in a steam boiler absorbs heat from the furnace until the water reaches 212° F., and then the heat converts the water into steam. In other words, *while boiling or vaporizing, a liquid absorbs heat.* This is the fundamental principle of refrigeration, and must be remembered. In the steam boiler, the vaporization takes place at or above 212° F. By choosing a liquid which boils at a much lower temperature than water, we can transform our steam boiler into a refrigerating apparatus. The water to be frozen takes the place of the hot gases in the tubes, and the liquid that boils at a low temperature takes the place of the water in the boiler. The process is the same except that it is carried on below ordinary temperatures.

Refrigerating Agents

There are several agents used in mechanical refrigeration; but ammonia is by far the most common, as it boils at a low temperature (−28° F.), is not too expensive, and can readily be handled. Compressed air is used on shipboard and in other places where ammonia fumes would be objectionable. As the ammonia compression system is the most common, let us consider it to the exclusion of the others.

How Cold is Produced

We know that when a liquid boils, or vaporizes, it absorbs heat. Therefore, to cool or freeze water we need only place it in contact with a liquid which boils at a low temperature—such as ammonia. The first sketch upon the blackboard represents a vessel, partially filled with liquid ammonia, placed in a tank of water. As the ammonia boils at ordinary temperature, it will readily vaporize, because of the heat in the water, and in doing so will reduce the temperature of the water. This is a primitive method of mechanical refrigeration, and is, of course, very wasteful of the refrigerating agent.



In the second sketch, the liquid ammonia in the vertical tank is allowed to expand into the coils of pipe which are immersed in the tank of water. This increases the efficiency, because more of the ammonia abstracts heat from the water. If ammonia were inexpensive, this apparatus would be sufficient for mechanical refrigeration.

The Three Operations

To make mechanical refrigeration commercially successful, it is necessary to recover the ammonia after it has vaporized and absorbed heat from the substance to be cooled, and to transform it again to a liquid. The modern compression plant comprises three fundamental operations—usually called Vaporization, Compression, and Condensation.

Let us assume the ammonia receiver to be partially filled with liquid ammonia. This ammonia is allowed to pass to the coils in the brine tank, the flow being regulated by the expansion valve. As the ammonia passes through the expansion valve and the coils, it boils or *vaporizes*, and absorbs heat from the surrounding solution. It then passes to the cylinder of the ammonia *compressor*, which is simply a specially constructed gas pump. In this cylinder the ammonia is compressed to a high pressure, and is still a gas, but very dense owing to the pressure. From the compressor cylinder it enters the pipes of the *condenser*, in which it is cooled by water which flows over the pipes. The cooling of this dense gas liquefies it. It then reenters the ammonia receiver, and is ready to follow through the various operations again. This, in brief, is the action of the refrigerating plant. Of necessity, some auxiliaries are added—as an oil trap between the compressor and the condenser.

This system is what is called the *indirect system*, because the brine (a solution of salt and water) is cooled to a very low temperature, and then circulated through the rooms to be cooled. In the *direct system* the vaporizing coils are placed directly in the rooms to be cooled, no brine being used.

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¶ The shallow head soon gets sore.

¶ Time knows nothing of a reverse lever.

¶ A little elbow grease is worth a lot of oily phrases.

¶ No amount of polish can make a pearl out of a pebble.

¶ A man's last will and testament is a dead give-away.

¶ It takes a noisy preacher to keep a small boy awake in church.

¶ A man always feels most liberal when he has forgotten to bring his cash.

¶ An Irishman says the easiest way to take a cork out of a bottle is to push it in.

¶ We are judged not by the poetry we applaud, but by the plain prose we apply.

¶ The man who is always hoping for the best may never reach it, but he has a happy time whistling on the way.

¶ Love usually tries to hide its noblest deeds.

¶ The man who is willing to face failure finds success.

¶ Living in the past only puts the headlight on the rear platform.

¶ Openings sometimes come to men and oysters when least expected.

¶ Nothing would please the small boy more than the privilege of assuming the rôle of father to the man occasionally.

The Late Senator Hoar

A PURE, ethereal flame that in an age of opportunism, scandal-breeding, and graft kept its radiance unsullied to the last—such was the life that has just gone out. In his independent worship of principles rather than men, George Frisbie Hoar, was neither Republican nor Democrat; he was American. Embodying throughout his entire career those unconquered ideals that are the glory of any Commonwealth, he showed forth what was good in all parties, while partaking of the evil of none. In this respect he loomed large, in remarkable and refreshing contrast to the ubiquitous pygmy of the present-day political arena.

To a degree unparalleled among the public men of the later generation, the country at large saw and respected in him that "righteousness" that "exalteth a nation." In the usual sense of the term, he was not a "politician;" and in the spontaneous tribute to his worth, which for nearly forty years gave him an uninterrupted share in the public counsels, he singularly emphasized the cynical falsity of Speaker Reed's definition of a statesman as "a successful politician who is dead." Senator Hoar never created a machine or stooped to the methods of the "boss." He never sought to harmonize personal desires with conscience, or to accommodate party expediency to inconvenient duty. The fact that at the close of a public career of unusual length his chief worldly accumulation was a magnificent private library, is a sufficient re-

buke to the all too common preaching that the chief end of a politician is to consider "what there is in it."

Though he left great impress on constructive legislation, he was not strictly one of the men who "do things." In the mechanism of political administration, his function was that of a balance wheel, not a driver. He was the *great conservative* of his party. The Constitution, the laws, the fundamental ideals of American liberty, were to him as sacred as the eternal principles of justice; and he never appeared to better advantage than when leading, under the banner of the Constitution, a forlorn hope against the onslaughts of what he regarded as a headlong Chauvinism that mistook its own impatient spirit of aggrandizement for love of country. Though almost fanatical in party fealty, and eventually losing in consequence somewhat of personal influence and power, he was a conspicuous and inspiring example of a man who served his country rather than himself.

Sea-Level or Lock Canal—Which?

SHALL the Panama Canal be a sea-level or a lock canal? This is a new question that has presented itself just as the construction of the great ditch is about to begin. Heretofore a lock canal has been regarded as the most practicable means of uniting the eastern and western seas. But George Eberlee, an American engineer, has made discoveries in four months which the French failed to make in fifteen years. According to Chief Engineer John F. Wallace, Eberlee has learned that it is possible to change the course of the Chagres river, making it flow into the Pacific instead of into the Atlantic, which diversion would entirely overcome the obstacle to a sea-level canal. Engineer Wallace, in a recent Chicago speech, declared that the diversion of the Chagres and the construction of a sea-level canal are now not only possible, but easily practicable. The cost of the diversion, according to his estimate, would be about $16,000,000, which is $20,000,000 less than the estimated cost of lockage works under the plan of carrying ships over a summit 85 feet above sea-level. The cost of the sea-level canal, including that of diverting the Chagres river to the Pacific, would not exceed $250,000,000. This is but $50,000,000 more than the estimated cost of a lock canal.

Mr. Wallace and the commission in charge of the work are said now strongly to favor the sea-level canal, and will ask Congress to authorize the additional expenditure necessary to its construction.

Before any such quick judgment is acted on, however, American engineers and Congress should carefully weigh the conditions. May it not be that the French also noticed the Chagres river and the possibility of diverting its flow? Others of the world's finest engineers surveyed the ground along the Panama canal. May it not be that in considering the possibility of diverting the Chagres, these European engineers found other difficulties that overweighed the apparent advantages? In the case of a sea-level canal, the effects of tides, ocean storms, and flood waters would introduce new conditions which would not affect a lock-system waterway, and which should be thoroughly investigated. This investigation can go on without delaying the work, for much of the labor will be identical whichever plan is decided on. The sea-level canal scheme has the more attractive appearance, but appearances are often deceptive.

The Block Signal System

DISASTROUS RAILROAD WRECKS of almost daily occurrence in the United States, demonstrate the necessity of equipping all railroads with the block system of signaling. This system makes wrecks by collision practically impossible, which fact is known to nearly all railroad officials; but they also know that it is generally cheaper to pay damages for deaths and injuries to

body and limb, than it is to install the new safety equipment and maintain the requisite force of operators. Out of 200,000 miles of railroads in the United States, but 26,000 miles are equipped with the block system.

The Interstate Commerce Commission, in a late report, says:

"Either from ineradicable mental infirmities in men of the most competent class, or from the employment of men more or less incompetent, collisions due to blunders and forgetfulness—usually of two or more men simultaneously—follow one another in endless and rapid succession."

The truth of this statement cannot be denied by any railroad man. The block signal system cannot forget, and its work is infallible with proper operators. It maintains a fixed minimum interval of space between two railroad trains traveling in the same direction on the same track. The railroad is divided into sections varying from one mile to five miles in length and called "blocks." At the entrance of the blocks, stands a post from 20 to 30 feet high, with a wooden or iron arm at the top. This is a semaphore signal, in whose vocabulary there are but two words, "Stop" and "Proceed."

In the telegraph block system the semaphores are controlled by operatives in towers, which are connected by telegraph. The generally prevailing normal condition of the semaphore arm is horizontal, which means "Stop." A train approaching a block cannot enter it until the tower man has lowered the arm to the side of the post, which position means "Proceed." The clear signal, however, is not given until the man at the next block has notified the preceding tower man that the block is clear. After a train has passed into a block, the semaphore is put to the "stop" position, where it remains until changed by the tower man so as to admit another train into his block.

The Interstate Commerce Commission has submitted to Congress a bill compelling the railroads to introduce the block system. It is not oppressive in its requirements. It gives the roads two years in which to install the system on one-fourth of their lines, and does not call for the completion of the work before 1909. The bill should be passed. It would save hundreds of lives yearly, and would wipe out the stigmatic reputation America now possesses in some quarters of the world, of placing an insignificant value on the lives of her citizens.

France's Liberal Auto Laws

FRANCE encourages automobiling in contradistinction to the American disposition to derogate its advantages. It is the liberal laws and the leniency in their enforcement which are responsible for the great popularity cross-country touring has attained in that country and which have placed France ahead of all other countries in the manufacture of automobiles and the promotion of motoring. France has thereby become the world's central market for motor vehicles of all kinds, and the popularity of the French machines is growing daily. Thus a great new source of revenue has been added to the European republic. French manufacturers do not have to contend with malicious laws, an unfriendly press, and resultant prejudicial public sentiment, which have so hampered American progress in the new industry.

The law of 1899, which governs automobiling in France, deals with the design of the car and the motor apparatus, requiring that it be substantially built and capable of making the speed claimed for the machine. Subsections of the law provide for the registration of owners, and for certificates of competency for those who desire to operate the machines. One subsection deals with the question of speed, and provides that "automobile races may not take place on the public roads without a speed permit delivered by each of the prefects of the departments interested." These permits are always obtainable upon request.

Hon. John Scott Montagu, in writing of the French automobile laws for the *North American Review*, says:

"With reference to the administration of the French automobile laws, it may be said they are usually leniently administered, and the police as a rule exercise great common sense in the application of the regulations. It is rarely that a touring car is interfered with

unless reckless driving is indulged in, through, or near towns. In the open country, police traps are never set; and it is small wonder, therefore that people are beginning to tour in France in increasing numbers every year, in consequence of the liberal treatment they obtain from the French public and authorities."

The result of these laws has been the exhibition of rural and urban France to thousands of tourists from all countries, and the exportation of thousands of automobiles to every civilized land.

American legislative bodies should take a broader view of the automobile, and assist in its development, instead of discouraging it. They should recognize the inevitable future of the automobile, which seems destined to supplant horse traffic on all the boulevards and select thoroughfares of our large cities, and probably in time on all the principal business streets. It is, we believe, a false idea of political popularity to cater to the blind and ignorant prejudice that at present exists against the motor vehicle in America.

Last Big World's Fair

WHEN the lights of the St. Louis World's Fair go out, they will probably obscure from view the last big exposition for many a year to come. At least, the prospects are that none now living will ever have a chance to see another of such mammoth proportions. Repeatedly these colossal shows have been tried, and each time they have proved unsuccessful financially and otherwise. World's fairs have been growing larger ever since the Centennial in Philadelphia, until now they have reached abnormal proportions, too colossal for beauty, convenience, entertainment, or profit. Every one of the world's big shows of modern times has proved a financial failure. The money loss of the St. Louis Exposition will be appalling.

In ground area, number of exhibits, and general magnitude, this has been the most stupendous exhibition that the world has ever seen or probably will ever see again. Writers, exhibitors, and visitors all agree that it is too large. No person could see it satisfactorily without four months of time to devote exclusively and laboriously to the task. It covers too much ground, the buildings are too scattering, and there are too many exhibits unworthy the space. Had the money expended in making the show of gigantic size been devoted to keeping the grounds in better condition, and to making many of the exhibits more attractive, the exposition would have been more beautiful and more profitable.

No person who has viewed the great city of temporary buildings, gorgeously trimmed with their myriads of lights, can desist from reflecting over the enormous waste of money, time, and energy. A dream city, in truth, viewed as a vision that no visitor probably would ever see again—vanishing as suddenly as it was born after its life of less than a year. "Think of the uselessness of it all!" the philosopher said.

At the Philadelphia Centennial Exposition the grounds measured 236 acres, and this was considered of monstrous size; at Chicago there were 658 acres; at Paris, 336 acres; at Buffalo, 300 acres. At St. Louis there are 1,200 acres. In a single building at the St. Louis Exposition, a person can walk nine miles in the aisles. The city standing on the exposition grounds numbers 1,576 buildings, the largest of which—the Agricultural Building—covers more than 21 acres.

The next world's fair probably will be smaller than any built since the Philadelphia Centennial. It will contain only the greatest things the exhibitors may have to display. The buildings, at least some of them, may be permanent, so that they can serve another purpose when the exposition is over. The grounds will be well-paved, perfectly free from mud; and the whole exposition will have a trim, finished appearance unknown to the present style of world's fair. The visitor who goes to see this will not feel lost in a maze of exhibitions and a million kinds of attractions. He can systematically view the show, know when he has finished, and have a comprehensive impression of what he has witnessed when through. The city that gives this kind of international entertainment will realize a gain and not weep over a loss, as is sure to result in the case of St. Louis.

A Triumph in Metallurgy

The Simplex Process of Separating Refractory Zinc Ores

By FLORENCE KING

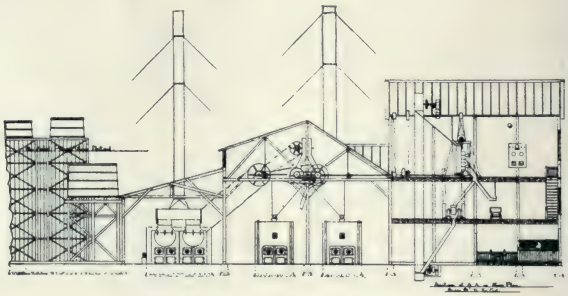
TO SEPARATE REFRACTORY ZINC ORES has long been a puzzling problem to miners. Nature has placed the ores in the ground in such a complex state that only a small percentage has heretofore been recoverable. It is not generally understood that seventy-five per cent of the gross product of the gold-silver-lead mine is of no value for the reason that it has been impossible to separate cheaply the zinc, lead, and iron pyrites; and the presence of these ores has made the smelter charges so high as to be prohibitive.

Mr. Eric Hedburg, a mining engineer of Joplin, Mo., has solved this problem by a recent invention, which he has patented. By this invention he is able to separate the elements of all refractory ores which it has been the custom to throw upon the dumps as worthless, and to utilize all the by-products therefrom in a commercially profitable way.

This process being electro-mechanical, it is possible to separate minerals having the same specific gravity, but which are impossible of separation by any mechanical or hydraulic method.

The process invented by Mr. Hedburg is continuous in its operation; and out of what has heretofore been considered waste material, he produces commercial zinc, the waste iron being converted into red mineral pigment, and the sulphur into sulphuric acid, all of which find a ready market.

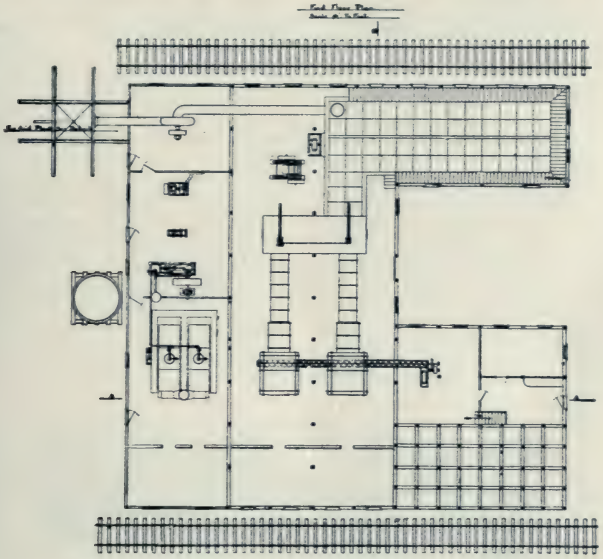
The accompanying diagrams show plan and sectional views of the Hedburg "Simplex" system of separating ores and utilizing the by-products. As the ore is received at the plant, it is piled upon a cast-iron floor under which the roaster gases circulate, where it remains until the concentrates are thoroughly dried. It is then elevated to a pair of revolving screens. All fine material passes through these screens and into hoppers located below, the coarse ore passing from the screens to a set of 24-inch high-speed crushing rolls, and back to elevator and screens the second time. The material is thus crushed to a size of 1-32 to 1-8 of an inch, for the purpose of releasing the



SIDE ELEVATION OF SIMPLEX SEPARATING PLANT.

intractable minerals and putting them in a condition to yield more readily to the subsequent treatment.

All the ore from the hoppers below the screens is conveyed by two screw conveyors to the roasters in a continuous stream. The latter comprise two White-

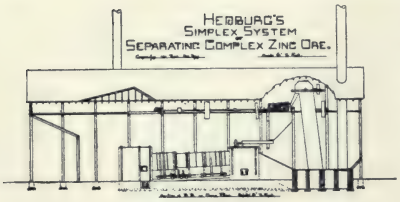


PLAN OF FIRST FLOOR, SIMPLEX SEPARATING PLANT.

Howell cylinder roasters, which revolve very slowly upon friction wheels placed beneath them. As the ore is passing through the roasters, it meets the flame from the fire-boxes, through which the ore is continually showered. This oxidizes the iron, and volatilizes the sulphur, without affecting the zinc. The ore, on its passage out of the roasters after all the sulphur is released, is passed through a gas chamber in connection with the roasters, where the iron becomes highly magnetized. The hot ore then passes into a water-jacketed screw conveyor placed below the roasters. In this it is cooled, and is conveyed to the elevator in the separator department, which takes the ore up to the third story, where it is discharged into a hopper, whence it passes onto two compound electro-magnetic separators charged with electricity of 8 to 12 amperes at 110 volts. These separators attract the magnetized iron, and separate the same from the zinc. Any zinc-iron not sufficiently crushed to separate easily, is attracted by the same machine, separated, and sent to a pair of high-speed crushing rolls, where it is re-crushed and then elevated to the screens and passed over the machines the second time for final separation. All the iron thus separated goes into a hopper located on the second floor, whence it is drawn into steel cars and trammed to the pigment plant for manufacturing paint.

All the freed zinc ore passes by the magnets, falls into a conveyor, and is sent to the ore bin for storage, from which it is drawn and sent to the smelters.

The sulphuric gas expelled from the ore in roasting, passes into the gas and dust settling chamber under the ore dryer floor, which is divided into four flues; these flues are connected in pairs for the purpose of cooling the gas by subjecting the same to extensive rubbing surfaces wherein it parts with contaminated coal dust, ashes, and pieces of ore



LONGITUDINAL SIDE ELEVATION OF ELEVATOR AND ROASTER.

dust. From this chamber the gas is drawn by a suction fan, and is forced to the sulphuric acid plant by first passing through the muffle furnace to be reheated. It is then sent through a bed of coke up the first tower, thirty feet in height, where it meets a spray of nitrated water showered from a tank above. The condensed acid descends from the tower, and runs to the first cast-iron kettle located in the muffle furnace, where it is boiled down and concentrated. The remaining gas, passing up the first tower, descends to the muffle to be reheated, and is then sent up a second tower under the same conditions; it then passes down, is reheated, and passes up the third tower, whence it is allowed to escape into the open air. The second and third kettles receive the acid from the last towers. All three kettles are connected together by pipes placed outside the muffle wall. They are provided with faucets near the bottom for the discharge of the sulphurous anhydride, which is stored in lead-lined air-tight vats, awaiting shipment to market.

The iron, freed from the sulphur and the zinc, is mixed with a portion of nitrate of soda, and slowly roasted in a reverberatory roasting furnace. It is then allowed to cool, ground in water, and hydrated in four right-angular vats for twenty-four hours, after which it is removed, allowed to dry, and placed in barrels, being then ready for market as pigment.

Lines on Lines

CURVED is the line of Beauty,
Straight is the line of Duty;
Walk by the last, and thou wilt see
The other ever follow thee.

Noon Hour Talks

The Virtue of Self-Esteem

AN OLD SCOTCH WEAVER used to pray that he might have a good opinion of himself; and while, on first thought, such a prayer seems to savor of conceit, a man cannot expect to win the good opinion of others if he does not think well of himself.

General Wolf

When General Wolf was appointed to the command of the British troops about to embark for Canada, he drew his sword, and, flourishing it around his head, spoke of the great things he would do. The Prime Minister, who was present, imagining that this was mere egotistical boasting, exclaimed: "My God, that I should have trusted the fate of the country and of the Administration to such hands!" But Wolf was not boasting; he simply had *a good opinion of himself;* and on the Heights of Abraham he showed Pitt that he could "make good."

Every Man His Own Appraiser.

Every person places his own price upon himself. In this busy, bustling world of ours, if you keep your light hid under a bushel, and do not make your ability known, no person is to blame but yourself if the tide of business affairs passes you by. The world takes a man at his own estimate, and has little or no use for any worker who goes about with an air of perpetual apology for the unpardonable sin of being in the world. Always show a good front.

Great Men Usually Egotists

Wordsworth never doubted the immortality of his poetry. Kepler, the famous German astronomer, had a justifiable conceit in himself. When the public neglected his book, he wrote: "I may well wait a century for a reader, since God has waited six thousand years for an observer like myself." It is usually wisdom to claim a little too much rather than too little, for the average man is able to accomplish more than he realizes, when it is imperative. If men had never achieved more than they really thought they could, the progress of civilization would have been delayed several centuries. You can never tell what you can do until you try. There is a good deal of bluff in the game of life, and it is well that there is.

The Meek Shall Inherit the Earth

The Bible says so; and, because of this statement, hundreds of people imagine that a man must never get angry, never take a decided stand, never wake things up with his protests, but always turn the left cheek when he is slapped on the right.

Some time ago an Irishman was struck by a fellow workman, and, amid the jeers of his mates, he turned the other

side of his face to his enemy and received another blow; but the jeers turned to astonishment when the Irishman exclaimed "Now, my boy, you have fulfilled the law," and immediately proceeded to thrash his tormentor thoroughly. It is doubtful if Patrick's interpretation of this passage of scripture would coincide with our modern exegesis; but it had a more lasting effect than the majority of sermons.

Who are the Meek?

The meek are not those who are never angry, who do not take their own part, who seem afraid to stand up for their rights. The meek are the individuals who show anger only when they ought to show it, who make an issue when an issue should be made. Meekness is not revenge, irritability, morbid sensitiveness, but self-defense and a quiet maintenance of rights.

An Ancient Philosopher's Advice

"Help thyself and God will help thee," said one of the old philosophers. On first thought, this sounds very irreverent; but the sentence simply expresses the idea of self-reliance. God is not going to perform miracles for the individual profit of any particular person. The average man has been placed in this world with all the bodily and mental powers requisite to master the conditions necessary to provide him with a satisfactory living. The outcome lies in the man's own hands. If he educates himself to respect his own ability, to place a good price on his brain and hand, to be self-reliant, and is not afraid to stand up straight and play his part, there is no question about the certainty of making a place for himself. The world wants such people. On the other hand, if he neglects to develop these qualities, he is certain to pay dearly for the neglect at some future time.

A Brutal Theory of Philosophy

This may seem such, and perhaps it is; nevertheless, it is the common philosophy of our age, the idea that is practiced all around you. Take a hint from the experience of many successful men. Show a good front, even if it means an effort.

The noblest men that live on earth
  Are men whose hands are brown with toil,
Who, backed by no ancestral graves,
  Hew down the woods and till the soil,
And win thereby a prouder name
Than follows king's or warrior's fame.

The Wagner Theater at Baireuth

Center of the Musical World

THE FAMOUS WAGNER THEATER at Baireuth, the Mecca of the musical world, is a center of attraction for music lovers of all nations, who flock there to attend the festival performances of the Wagner operas, which have made the little town in Bavaria famous. The theater was constructed in 1872-76, through the liberality of Wagner's patron, Ludwig II., the mad king of Bavaria, solely for the purpose of producing the Wagner operas. The auditorium seats 1,750 persons, and every seat costs a sovereign, or about $4.86. The theater was opened in the summer of 1876, with the first complete performance of "The Ring," at a loss of about $37,000. This performance was conducted by Dr. Hans Richter, who still wields the baton.

Frau Wagner has devoted her widowhood to the praise of Wagner. She has been reared on music, for she is the daughter of a great pianist, has been the wife of two composers, and the mother of a third. Her father was the famous Liszt, who was a Hungarian. She was first married to Hans von Bülow, and secondly to Wagner. Her son, Sigfried Wagner, was born in 1869. She lives at Baireuth in the Villa Wahnfried, and takes the keenest interest in the festival.

WAGNER THEATER, BAIREUTH, BAVARIA

The Mecca of the devotees of Music. Founded through liberality of Ludwig II., the Mad King, solely for festival productions of Wagner's operas.

Life Stories of Successful Men

Herbert H. Vreeland

By HENRY M. HYDE
Author of "The Buccaneers"

IN 1867 a little boy of ten years was driving a grocer's delivery cart in Jersey City; three years later the same boy was working with an ice-cutting gang on the Hudson river above New York; at eighteen years he was shoveling gravel on a Long Island railroad night-construction train; at thirty-six he was president of the Metropolitan Street Railway Company of New York, directing the handling of 600,000,000 passengers yearly—more than are carried on all the steam railroads in the United States.

Between the two extremes of this career, lies one of the most inspiring stories that a young man can read. It is especially inspiring because it makes so clear the essentials of any large success. And the first of these is hard work. Beginning before many boys are out of the nursery, Herbert H. Vreeland was hard at work for twenty-six years before he became president of the Metropolitan. Once, when laid off as a railroad switchman, he sought and accepted a job at sweeping and dusting out unused passenger cars. There was no such thing as false pride about this future general manager and president.

All through his story the qualities which insured his success stand out prominently. At the age of twenty he was made brakeman on an early morning train to Hempstead. Already he was a tall young fellow, standing a trifle over six feet in height, and weighing more than 200 pounds. He carried himself well, too; and one morning an old passenger who had seen a deal of the world took occasion to poke a little fun at the new brakeman.

"I suppose you think your fortune is made now, Vreeland," laughed the graybeard. "Let me tell you how it will work out. You'll be promoted by and by to be a conductor at $100 a month, and there you'll stick until you are discharged."

"Don't you believe it," replied Vreeland, almost angrily. "I'll never be satisfied to remain a conductor. I'm going to be president of this road some day."

So all up and down the little road the other "boys" got to calling him "President" Vreeland. It was a great joke then. But the joke has long since lost all its point. The incident, however, still holds a mighty moral. The young brakeman had ambition. Without ambition no man can travel far.

Here is another mile post in the progress of Vreeland: His first regular job on a railroad was that of a switchman at a temporary switch in a desolate marsh near the station of Bushwick, Long Island. While on that job, Vreeland had to sleep part of the time in a tent. His switch was not far from the Bushwick station, and, when off duty, he spent most of his time there, getting acquainted with the men in charge and studying their work. Vreeland was so anxious to learn the technical part of railroading that he volunteered to help the Bushwick agent in making out his accounts. Often he worked until midnight figuring on freight and passenger reports and getting a thorough understanding of that branch of the business. He was taking what was practically a correspondence course under circumstances the most difficult possible. His thirst for accurate and technical knowledge was one of the great factors in his success.

While a switchman, the superintendent asked the young man's boss if he could recommend somebody to take the place of a brakeman whose carelessness had caused a collision.

"I've got a young fellow named Vreeland here," was the answer, "who will do exactly what you tell him to do."

Evidently the ambitious youth had already learned the truth of the old adage —"He who would learn to command must learn to obey."

While brakeman he was one day assigned to serve on a special train which was taking the president and directors over the road. They asked many questions. The tall, well-set-up young brakeman smilingly answered most of them.

Next day the superintendent sent for Vreeland.

"Are you the good-looking young brakeman who was on the president's special yesterday and who shows his teeth when he smiles?" asked the superintendent.

Smilingly Vreeland answered that he was certainly the brakeman on the special.

"The president wants to see you upstairs," said the superintendent.

Already his technical knowledge, backed up by his ready courtesy and his good manners, was telling in his favor. The president had him relieved from his regular duty and gave him personal charge of a somewhat difficult arrangement. Vreeland carried it through successfully, and spent the next few months acting as a personal emissary for the president, in which capacity he learned self-reliance and acquired the ability to take responsibility on his own shoulders.

Then the Long Island road changed hands, and Vreeland was "let out." That was a hard blow, but he showed another quality necessary to success by not letting it discourage him. He quickly got a job as conductor on a little jerk-water line called the New York & Northern Railroad. There he worked some years, the qualities already outlined pushing him forward until he became trainmaster and practically "ran the road."

HERBERT H. VREELAND.

While Vreeland was in this position, the New York & Northern was sold to a syndicate at the head of which was the late William C. Whitney. But this time the change in ownership brought Vreeland to his own. Mr. Whitney, Daniel S. Lamont, and the other new owners took a trip of inspection over the lines of their new purchase. Trainmaster Vreeland was in charge of the train. Whitney asked a great many questions not only about the physical condition of the road, but also about its freight and passenger traffic. Vreeland's self-acquired knowledge of railroad engineering and construction was so great, and he was so well acquainted with the statistics of traffic on the line, that he was able to give Mr. Whitney just the information he was after. The result was that not long afterward Vreeland was made general manager in the place of the older official who was not a practical railroad man.

Nor did the effects of that inspection trip stop there. Some months later, General Manager Vreeland got a telegram from Mr. Whitney: "Meet me at Broadway and Seventh avenue office at 2 o'clock to-day," it said. In order to keep that appointment, it was necessary for Vreeland to take a special engine and make a fast trip. He did it without stop-

ping to make any further inquiries, appreciating the importance of promptness. When he got to Mr. Whitney's office, the great man was out at his lunch. Vreeland sat down and waited for half an hour. Then he got up and spoke to Mr. Whitney's secretary.

"My name is Vreeland," he said. "I had an appointment here with Mr. Whitney at 2 o'clock."

"Mr. Whitney expected to be back by 2 o'clock," was the answer; "but he has evidently been detained. Here is a letter for you."

Vreeland tore open the envelope, and this is what he read:

"MR. H. H. VREELAND,

"Dear Sir:

"At a meeting of the stockholders of the Houston Street, West Street & Pavonia Ferry Railroad Company, held this day, you were unanimously elected a director of the company.

"At a subsequent meeting of the directors, you were unanimously elected president and general manager, your duties to commence immediately.

"Yours truly,

"C. E. WARREN, Secretary."

Before Vreeland had fairly recovered from his astonishment, Mr. Whitney and a party of the directors came in. To most of them, Vreeland was an unknown man. Only to the unerring judgment of Mr. Whitney had he already proved his worth. Mr. Whitney introduced his fellow financiers to their new head. Then he and the rest put on their hats and left.

"Well, Vreeland," said Mr. Whitney, as he went out the door, "you're president now. Go ahead and run the road."

That was all. It marked the beginning of the great Metropolitan Street Railway Company of New York, to the creation of which the financial genius of Mr. Whitney and the expert technical knowledge of Mr. Vreeland contributed in almost equal proportions.

How well Vreeland has done his work, the history of the Metropolitan may tell. That it is appreciated by the directors and stockholders of the road, is sufficiently shown by the fact that in 1900, when the tact and firmness of Vreeland had prevented a strike of the 15,000 employees of the Metropolitan, the stockholders, by unanimous vote, presented their president with a check for $100,000.

Hard work, obedience, ambition, courtesy, all backed by a tremendous thirst for technical knowledge, to be acquired in the scanty leasure left after a day's hard work at manual labor—these are landmarks in the rise of Herbert H. Vreeland.

Where is the man who can truthfully say that it is impossible for him to follow the same pathway?

Professor Bell's New Kites

An Explanation of Principles which the Inventor of the Telephone is Applying to the Solution of the Problem of Aërial Navigation

By GEORGE CAMPBELL

PROF. ALEXANDER GRAHAM BELL, the inventor of the telephone, has for several years past been deeply absorbed in an effort to solve the problem of aërial navigation; and, as a means to this end, he has invented a new type of kite which is in itself decidedly interesting, and which, all other considerations aside, is bound to prove highly useful in this age of scientific kite-flying for weather forecasting and other purposes. Incidentally he has brought forward an idea which is not only a distinct advance in aërostatics, but is in many respects an application of principle new to science.

The inventor feels confident, moreover, that he is on the direct road to a solution of the problem of navigating the air, and hopes to bring about this consummation before very long. He has made arrangements for a test in the near future of a motor that he has invented for use in connection with his style of kites, in order to evolve a flying machine which will be completely under the control of the operator at all times. The dirigible balloon, which has served as the foundation for the experiments of Santos-Dumont and many another inventor, has no place in Professor Bell's calculations. All his work has been along the line of finding a solution by means of kite structure.

When Professor Bell entered upon his investigation he found that all existing box kites and flying machines of this order were defective in two ways. For one thing, the box kite is braced in a horizontal and vertical direction, but not otherwise, so that cross supports have to be introduced in the frame, which increase the weight without adding to the flying power, and at the same time operate as an obstacle to the wind. Secondly, the box-kite type of airship increases in weight with the cube as rapidly as the lifting power increases with the square; hence the larger the kite, the less it will lift in proportion. Possibly some of our readers may find in these facts a partial explanation of the recent failure of the aëroplane invented by Professor Langley of the Smithsonian Institution, small models of which were operated with a degree of success that did not attend the experiments with the full-sized machine.

PROFESSOR BELL DEMONSTRATING THE TETRAHEDRAL PRINCIPLE.

The obvious objections to the box-kite form of construction led Professor Bell to construct a kite the frame of which presents the form of a triangle no matter from what side it is viewed. In other words, the frame is a perfect *tetrahedron*, which is defined by the dictionary as "a solid bounded by four plane triangular surfaces, and having therefore six edges

and four verticals." The best idea of the characteristics of such a unit of construction may be gained by constructing an experimental tetrahedron from toothpicks or small pieces of wood all of equal size and length. Three of these pieces of wood are bound together in the form of a triangle; and then, in each of the three corners of this foundation triangle, is fastened one end of another of the uniform-sized pieces. The tops of the three

Bell Tetrahedral Kite in Air.

uprights are then drawn together and fastened much after the fashion of the poles of an Indian tepee.

Simple tests will demonstrate that such a structure possesses surprising strength in proportion to the size and stability of the individual pieces of which it is composed. Indeed, a kite frame made up of several of these tetrahedrons, which was recently fashioned by Professor Bell, and which, being constructed of aluminum, weighed little more than three pounds, yet supported, without any evidence of strain, the weight of a man weighing 160 pounds. The main advantage, however, which Professor Bell has gained in his new kite structure, is found in the fact that it is self-braced in every direction, and that the lifting power increases proportionately with the increase of weight.

A kite of the type devised by Professor Bell, it should be explained, is composed of a number of these tetrahedral units. One of the advantages claimed for this class of construction is that the units may be grouped in any form desired, just as a person can build a house of any design. The kites will ascend when apparently there is scarcely a breath of air stirring, and they are very easily managed when in the air. The kite frames are covered with silk or other material of light weight but strong texture. Only the smallest-sized kites are handled by means of cord. Steel wire managed from a windlass is utilized in the case of the larger kites. At his great laboratory at Burdetts, Nova Scotia, where he spends his summers, Professor Bell has kites constructed in accordance with his new principle, which have readily lifted to a considerable height a man weighing 200 pounds.

Professor Bell does not wish the public to gain the impression that he has constructed a full-fledged flying machine. He says modestly that his experiments have not yet passed the kite stage; but he is confident that when the problem of overcoming gravity is solved, the tetrahedral principle of construction will be found to have advantages over the ordinary flat-surface aëroplanes in the matter of cost and weight. Certainly there is much to be expected from his discoveries, since the tetrahedron is the only known unit of construction which offers a corresponding increase of lifting power with increase of weight.

Magnetic Clutches

The Importance of their Application to the Driving of Machine Tools

By JOHN S. McKEE

Student, American School of Correspondence

SINCE THE ADVENT of individual motor-driven machine tools, the successful application of magnetic clutches has made possible the operation of an entire machine shop concerning which it may be said—"There is neither line shaft, counter-shaft, nor belt therein."

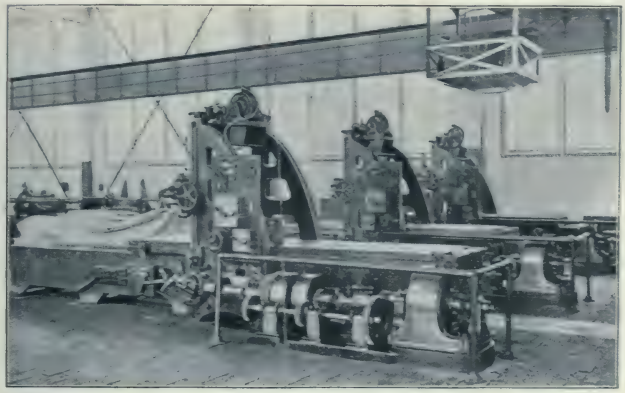
The utilization of magnetic clutches in driving planers has made a decided difference in the economical operation of these machines, as it has increased the output by making possible a variety of speeds, the operator being enabled to change the speed to suit the work. The planers can be run at a much higher speed than formerly, as there are no belts to slip or burn, and, in securing high speeds on belt-driven planers, the belts would have to be made so heavy that considerable difficulty would be experienced in shifting them.

Magnetic clutches, moreover, are very positive in their operation, so that it is possible to work very close to a shoulder or offset. A test was made on a 96-inch planer by setting it so that it would run the tool within 1-32 inch of a shoulder; one hundred strokes were made, and the reverse did not vary enough to allow the tool to touch.

In using these clutches, a machine can be thrown out of action from any number of points at any distance, depending on the number of switches placed in the clutch circuit.

The current required by the clutches is surprisingly small considering the amount of power transmitted; on a certain planer it required only .75 ampere to pull two cuts through cast iron, each being 3-32 inch x 2½ inch, at the speed of 14 feet 3 inches per minute.

This cut does not really indicate how much the clutches will pull as it is just the ordinary work accomplished by the machine mentioned. One of the clutches in use on this planer was tested by putting a strain of 60,000 pounds on it in an attempt to separate the armature from



POND PLANERS, 36x36-INCH, OPERATED BY MAGNETIC CLUTCHES.

the magnet. How much more than this it would have successfully withstood, cannot be stated, as the parties making the test would not put any greater strain on their apparatus. This test was made on a 33-inch clutch.

In the accompanying illustration of a 36-in. x 36-in. planer, it will be noticed that there are three gears of different diameters on the left-hand clutch, and there is a field rheostat on the side of the housing of the planer; this will give three different speeds by changing the gearing, and a variety of intermediate speeds from field regulation on the driving motor.

The driving member, in this case, is an ordinary shunt-wound motor driving a pair of clutches through what is known as a "five-gear reverse." The right-hand clutch controls the return of the platen; and, as the driving and driven gears are of about the same size, a very high speed is obtained.

A magnetic brake is shown at the right of the clutches, and is a very important adjunct to this equipment; should the planer be working very close to the limits of its stroke and the power fail, the platen cannot drift beyond safe limits, as the brake will set and stop the machine instantly. The brake also comes in very handy in setting up work, as the operator can depend upon it to stop the machine the instant he opens the switch.

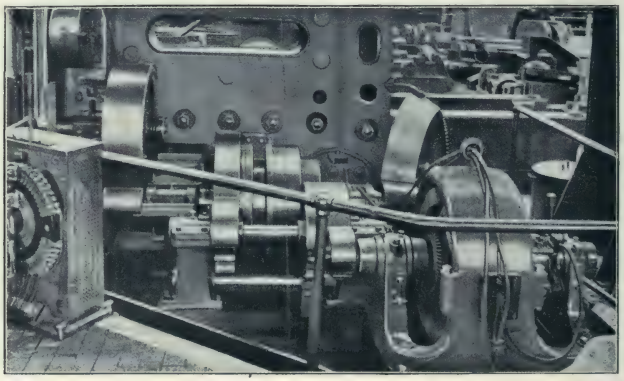
Magnetic clutches have been very successfully applied to machines for tapping out pipe fittings; in these machines the taps are run in a certain distance, and then reversed to run them out. The tapping machines run at such high speeds that ordinary mechanical or friction clutches will not stand up to the work, or, if the clutch is made heavy and positive enough to do the work, it soon tears the machine to pieces; every time the mechanical clutches would reverse, the jar would affect the entire shop. Since magnetic clutches have been applied, however, the machines reverse so noiselessly that it is necessary to watch them closely to tell when the reversing occurs.

The line shafting in shops and mills can be connected up in sections by using magnetic clutches; and any section can be instantaneously disconnected by snapping a switch located anywhere in the shop, or from any one of a number of points, as might be desired.

Magnetic clutches can be so arranged in connection with counter-shafts that, instead of using a belt shifter, a small switch fastened to the machine is all that the operator will have to move. By this arrangement the counter-shaft does not have to be located directly over the machine, as is the common practice at present.

This system of clutches is almost ideal for use in cotton or woolen mills, where it is absolutely necessary to stop a loom instantly should a thread break in the weaving.

It requires very little force, and but an instant of time, to set or release a mag-

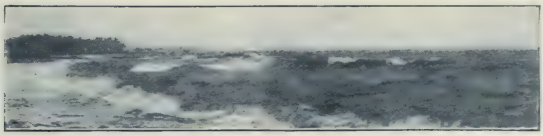


A 72x72-INCH DETRICK & HARVEY PLANER OPERATED BY MAGNETIC CLUTCHES.

netic clutch; and it does not require any more exertion to set a large clutch than it does to set a small one; in either case it would require about the same effort as to switch on or off an ordinary incandescent lamp.

Residual magnetism has been the great bugaboo in most of the attempts to use magnetic clutches, but this source of trouble has been eliminated so that their positive operation can be depended on.

There is hardly a limit to the amount of power that can be transmitted; and, considering the ease with which magnetic clutches can be operated, it seems that there is a great field for them when they come to be thoroughly understood. As they have already proven very practical, any person with mechanical ideas and a little ingenuity can see many more uses to which they can be put than those mentioned in this short article.



Dinner-Pail Philosophy

¶ A white life preaches louder than a black tie.

¶ God s love was not meant as a cushion for our laziness.

¶ Nobody makes any particular progress by patting himself on the back.

¶ It is a pity that when people reach the age of discretion they do not stay there.

¶ One way to improve the memory is to assume for a moment that you have everything you want.

¶ Young man, beware of the girl who lets you do all the talking during courtship; she's playing a waiting game.

¶ One of the great drawbacks to the budding poet is the refusal of the Government to supply postage stamps on credit.

¶ Things that are almost right are altogether wrong.

¶ The bee that gets the honey doesn't loaf around the hive.

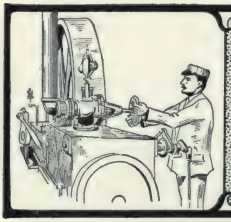
¶ The tardy scholar thinks a rod in the bush is worth two in the hand.

¶ Decoy ducks are said to be popular with boarding-house proprietors.

¶ There is very little common sense in this world; most of it is decidedly uncommon.

¶ In union there is strength—so a meek and lowly man with a strenuous wife says.

¶ Grease spots may be quickly removed from clothing with the aid of a small pair of scissors.



ENGINEERING PROGRESS

Fireproof Paint

AN INTERESTING TEST of paint for resisting heat was recently made in the suburbs of New York. Two sheds were erected of pine wood. To make the material more inflammable, each building was surrounded with straw. One was painted with what was claimed to be a fireproof compound, and, in addition to the straw scattered around its foundation, contained straw inside. The other shed was not protected.

Fire was applied to a heap of straw between the buildings so that the flames attacked both structures at the same time. Seven minutes after the fire started, the unprotected shed was ignited. In twelve minutes its side nearest the fire was ablaze; and in thirty minutes it had collapsed, a mass of ruins. The painted shed, as shown by the photographs, was at this time practically unhurt. The straw inside burned, but here also the fireproof paint protected the building, the only effect being to scorch the surface of the boards slightly. The accompanying photographs show the buildings during various stages of the test.

FIG. 1. TEST OF FIREPROOF PAINT.
Two months after being painted. Structures ready for the fire.

FIG. 2. THIRTY-TWO MINUTES AFTER FIRE STARTED.

Replacing a Railroad Bridge

VERY RECENTLY a remarkable piece of engineering work was performed on the line of the California Northwestern Railroad.

This road extends from San Francisco to the town of Sherwood in Mendocino County in the same State—a total distance of about 150 miles. Its construction involved the cutting of several tunnels and the erection of many bridges.

LAST TRAIN CROSSING WOODEN DRAWBRIDGE OVER PELELUMA CREEK, AN ARM OF SAN FRANCISCO BAY, CALIFORNIA.

Before the next train whistle blew, this span was replaced by a steel structure.

Near the city of Peleluma, a narrow arm of the great Bay of San Francisco, known as Peleluma Creek, is crossed by the main line of the railroad. As the channel is navigable for small craft, the bridge at this point is provided with a draw.

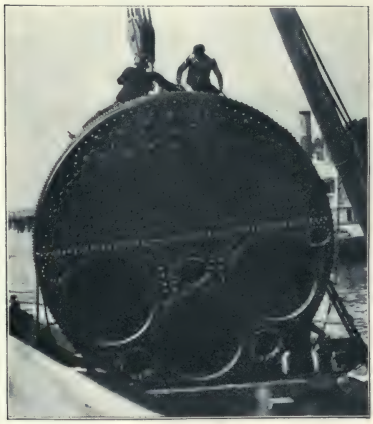
The first bridge spanning the brackish "creek" was constructed principally of wood. It was determined recently to re-

NEW STEEL DRAWBRIDGE OVER PELELUMA CREEK, CALIFORNIA.

On line of California Northwestern Railroad. View taken just after workmen had set span in position, replacing wooden draw shown above.

place the old structure with a new steel one.

The entire new span (the long draw reached from bank to bank) was constructed on shore, the trains meantime passing over the old structure. It was determined to "change bridges" without detaining any of the trains a moment.



MAMMOTH MARINE BOILER BEING LOWERED INTO THE HOLD OF A VESSEL.

When everything was in readiness, the old wooden structure was hastily wheeled around, and pulled ashore at one side. Then, by means of very powerful tackle, derricks, and other appliances, and a large force of workmen, the new and immensely ponderous steel span was quickly swung into position and accurately balanced on the central stone pier. Everything was in perfect working order and the rail connections made at each end, before the whistle of the next train was heard. The interval between "train times" was only a few hours. The incident has rarely, if ever, been paralleled in Western railway history.

Usually, when one bridge supersedes another, the plan is to build the new structure so that the old one is removed piecemeal as work steadily advances. In this instance, however, the change was made in a remarkably short space of time, and without causing a moment's interruption of traffic.

One of the photographs shows the last train crossing the old bridge; the other, the new span just after it was swung into position, together with part of the force of workmen.—J. MAYNE BALTIMORE.

Mammoth Steamer Boilers

BOILERS OF IMMENSE PROPORTIONS have been installed on the steamer *Santa Maria,* which plies between Chicago, Buffalo, Cleveland, and others of the principal Lake ports. The *Santa Maria* is strictly a freight vessel. The boilers are the largest in use on the Great Lakes, and the vessel contains three of them. They are each 15 feet in diameter, 13 feet long, and contain 278 tubes, each 3½ inches in diameter. Each of the boilers carries a working pressure of 150 pounds, and weighs 50 tons. The illustration shows one of these enormous steam generators as it is being lowered into a vessel.

Concrete Bridge

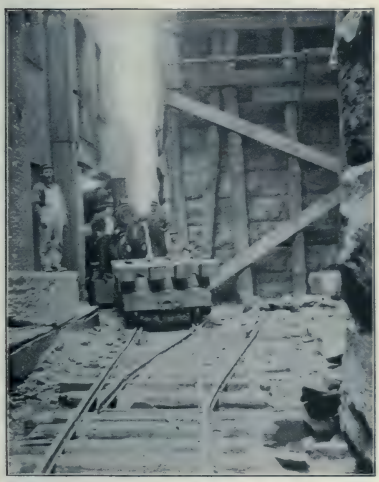
A BRIDGE built entirely of concrete spans the Nervion river at Bilbao, Spain. It was recently built for a new electric line, and is constructed of Hennebique's ferro-concrete. The bridge comprises three arches perpendicular to the axis of the river, and two skew arches at 45 degrees. Each arch has a span of 115 feet, and is composed of two ferro-con-

CONCRETE BRIDGE ACROSS NERVION RIVER, BILBAO, SPAIN.

crete arched beams, supporting pillars on which the floor of the bridge has been constructed. The whole forms a monolithic construction of great strength.

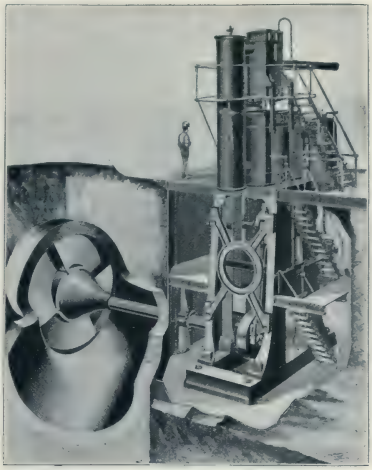
Shifting Right of Way

PEOPLE who are familiar with the Pennsylvania Railroad would not imagine that the accompanying view is a portion of its main line between Philadelphia and New York as it appeared about a year ago; but such is the fact. In order to shorten the



TEMPORARY SHIFTING OF RIGHT OF WAY ON MAIN LINE OF PENNSYLVANIA SYSTEM, BETWEEN NEW YORK AND PHILADELPHIA.

time between the cities mentioned, the company has been building elevated ways through the towns between them. The tracks have been laid on massive embankments faced with masonry. In some places it was necessary to do the work so hastily that the contractors did not stop to tear down entirely a building which might be in the right of way, but merely cut a hole through it and finished its demolition later on. In one instance a hole was cut through the walls of a large brick factory at the second story, and the track laid through this aperture supported on a wooden trestle until the permanent foundation could be completed. Over this route the engines drawing the construction trains, as well as some of the local passenger trains, were operated for a week or more, until the rest of the building could be torn down. The picture shows the engine of a dirt train emerging from the building.



REYNOLDS SCREW PUMPING ENGINE.

Built for Milwaukee (Wis.) Flushing Tunnel. Capacity 500,000,000 gallons in 24 hours.

Marvelous Pumping Machine

FORCING 500,000,000 GALLONS OF WATER every twenty-four hours through a 12-foot tunnel from Lake Michigan into the Milwaukee river, a screw pumping machine installed in Milwaukee has earned the distinction of handling the greatest quantity of water of any single machine in the world. The pump, built for the Milwaukee flushing tunnel, was designed especially for handling large quantities of water under low head. Its designer is

THIRD RAIL USED IN ELECTRIC RAILWAY SIGNAL SYSTEM.
Semaphore remains up while car is on block.

Edwin Reynolds, for whom the machine is named.

The pump proper is a modified form of propeller wheel with screw-shaped blades. It is mounted in a cast-iron circular housing or casing, which is set in the brick walls of the tunnel. The wheel is keyed to the crank-shaft of a vertical compound engine. Suitable bearings for supporting the outer end of the crank-shaft are formed in the wheel casing, these being fitted with devices for adjusting the journals and keeping the shaft in line. The engine is of the vertical compound-condensing type with steam-jacketed cylinders, attached air-pump, and jet condenser. It is set in a boiler-iron pit far enough below the intake level to keep the wheel always submerged whether it is running or at rest. The small amount of fuel consumed in proportion to the large amount of work performed, has established the machine's reputation as a modern mechanical wonder.

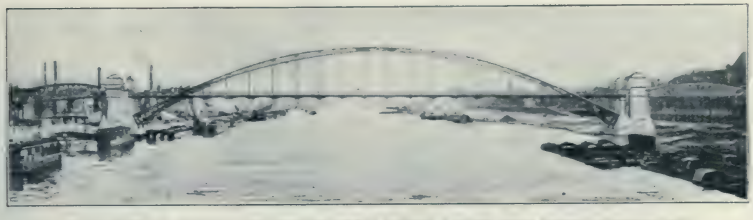
Electric Railway Signals

USE OF THE MAIN-LINE CURRENT for operating any system of electrical signaling is the feature of a simple and novel invention of William H. Jordan of New York. The application of the signal system to a third rail is shown in the illustrations. A shoe or other contrivance is carried on the car, and makes contact between the main-line conductor and a section of signal rail or wire, forming a divided circuit, a portion of the current passing through the proper signaling apparatus (which may be in the form of a bell, a semaphore arm, or a series of lights) and then grounding. In the system illustrated, only a section of signal rail is used. In this case the current operates a solenoid, which, as the car enters a block section, throws the signal arm in position in the daytime and lights a series of lamps at night. As this car leaves the block at the other end, current is caused to flow in a similar magnet, which thus throws the arm or the lights to "Clear."

In another method of employing the system, the right of way is divided into blocks, the signal wire for each block being insulated from the blocks immediately before and after. In this case, however, it is necessary to have a continuous signal line for the whole distance of a block. This causes a signal lamp to burn, or a semaphore arm to show

THIRD-RAIL ELECTRIC RAILWAY SIGNAL SYSTEM.
Semaphore down indicates clear line.

danger, as long as a car is on the block and a current is flowing through the signal apparatus. To increase further the utility of the system, an annunciator in series with the signal box may be installed in the dispatcher's office, the signal wire grounding at the dispatcher's office instead of at the signal box. The system eliminates the use of local batteries; and, as the current is used from the line operating the cars, almost any form of signal apparatus may be installed.



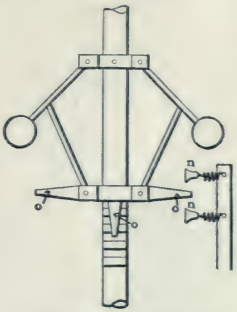
SINGLE-SPAN BRIDGE TO CROSS RIVER SEINE ABOVE THE PONT AUSTERLITZ.
On line of Paris Metropolitan Railway.

New French Bridges

TWO SPLENDID BRIDGES over the Seine river are to result from the completion of the Metropolitan Railway of Paris from Passy to the Bastile. One will be a single span, to cross the river above the *Pont Austerlitz;* and the other, a double-decked, five-span structure at Passy. The bridge at Passy will be a magnificent specimen of architecture, with a boulevard intersecting its central span. One of the double platforms will be for trains, and the other for ordinary traffic. Both the bridges were designed by M. Biette.

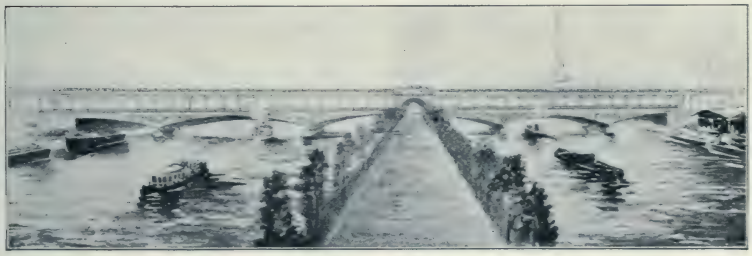
Speed Indicator

FOR CALLING ATTENTION to changes in speed of running machinery, whether above or below the limit required, a simple device is shown in the accompanying self-explanatory sketch from the *American Miller*. The points *o* normally pass between the spring-mounted bells *n*. If the speed of rotation increases, the points rise and strike the upper bell, while if



SIMPLE SPEED INDICATOR.

the speed decreases the lower bell is struck. These bells may have decidedly different tones, so that it can be detected at once whether the speed is too fast or too slow. The rise and fall of the governor is also indicated by rings on the central spindle.

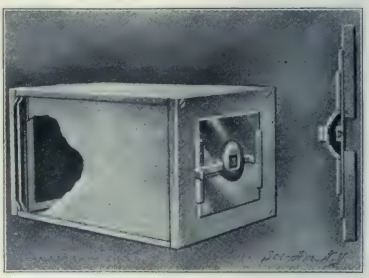


DESIGN OF PROPOSED BRIDGE AT PASSY, NEAR PARIS, FRANCE.
On line of Paris Metropolitan Railway.

Pictures Without Lenses

PINHOLE PHOTOGRAPHS are obtained by means of a pinhole punched in tinfoil and made to serve the place of a lens in the camera. Excellent pictures, strange and interesting, are thus obtained, and pinhole photography is becoming one of the fads of the day. The pictures lack the extreme sharpness of those obtained by a regular photographic lens, but they have a greater softness of tone which is delighting to the eye and which is equaled only by the artist's brush. A needle serves better than a pin for punching the hole in the tinfoil. The hole must be perfectly round and smooth. Through this the light is admitted to the sensitive plate, the exposure being made in the regular manner. Mr. N. R. Briggs, who has made a study of the new-style photography says:

"The interest manifested in this new objective is due to the fact that it is of universal focus, the rays focusing in the stop; the perspective is true, no part of the picture being out of focus, while interior and architectural photographs are rectilinear, that is, without distortion of any kind, for the rays of light fall directly upon the plate without any interference. It is said that work requiring the sharpest definition, such as copies, reproductions of documents, etc., can often be done better by the pinhole objective than with a fine lens. The reason is obvious. A lens often focuses sharper than the eye, giving a staring, unnatural effect to the resulting print."



LENSLESS OR PINHOLE CAMERA.

PHOTOGRAPH TAKEN WITH PINHOLE CAMERA.

The *Scientific American* says:

"Another singular feature in connection with pinhole photography is that any size camera may be used. For instance, it will take a picture upon a plate three inches long or twenty inches long. Therefore, it will be seen that all one has to do is to arrange this camera for a small or large plate; and with the latter, interesting panoramic views could be secured. There is no doubt that a very cheap and sat-

isfactory folding camera, in which to use any of the present series of roll films, could be made for special panoramic work."

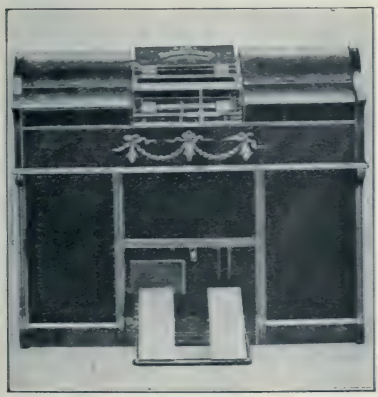
Mr. Charles G. Willoughby of New York is another pinhole photography enthusiast, and it was he who took the picture—a fountain in Central Park, New York City—from which one of the accompanying illustrations was made.

Mechanical Paderewskis

AN INVENTION designed to permit the performer on a mechanical piano-player to reproduce music exactly as it would be played by Paderewski or other noted artists, has made its appearance in Europe. It is an attachment to the piano-player and is called the "metrostyle." It consists of a metal pointer or index, which is attached to the tempo lever of the player. By its means, the performer, when playing, is enabled to follow a line printed in red on the music rolls. This line indicates exactly the interpretation of the composition as played by the composer or other well-known musician.

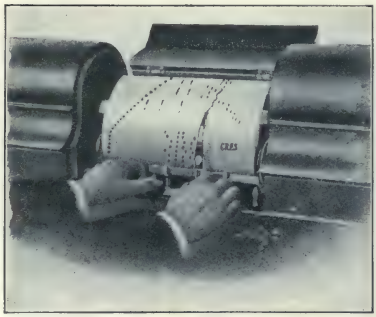
The original line is obtained by means of a pen affixed to the metrostyle when the expert pianist is performing. This pen traces a red line on the unwinding roll, which line indicates the artist's individual reading of the composition, with all the changes of tempo, and the very lightest and most subtle shading and nuance. The rolls thus marked are kept as records, from which facsimile reproductions are made for the market.

MUSIC ROLL.
Showing metrostyle marking by I. J. Paderewski, and bearing his holographic authorization.



MECHANICAL PIANO-PLAYER.

Prior to this invention there had been no authority or standard to show how the composer intended a piece to be played, or how a great pianist would interpret it. The performer had to trust entirely to his own judgment and taste. The inventor claims that the metrostyle, by providing authoritative interpretation, creates a new factor in musical progress. Besides enabling the amateur to imitate the interpretation of noted pianists, the attachment makes it possible to contrast the rendering of certain works as played



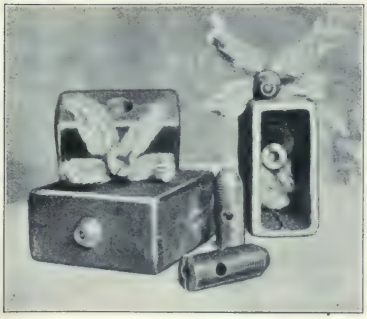
Showing Pointer and Marking on Music Roll.

by different virtuosi. No two pianists give a composition just the same interpretation. Paderewski, Rosenthal, or Moszkowski would none of them play a Chopin nocturne alike, although each would give a finished and thoroughly artistic performance. Such a comparison of the different readings cannot fail to form an interesting and instructive study. Probably in fifty or a hundred years from now, metrostyle rolls will be referred to when it is desired to hear the masterpieces as played by the virtuosi of the present time.

Car-Journal Oiler

A NEW DEVICE for using oil on car journals has been put into service on several of the electric interurban lines of the Central West. The contrivance is shown in the illustration. It is a modification of the siphon-wick type. The lower end of the tube contains a valve preventing feeding when the car is not in motion.

The use of oil and waste in lubricating railway motor bearings has proved very successful. Improper materials and poor attention, however, are sure to give poor results. A high grade of wool waste should be used. It must be elastic in order at all times to maintain some pressure against the shaft, even though the lubricant is applied from below as in motor axle bearings. The elasticity is sometimes increased by the addition of a small amount of Japanese or India fiber.



Oiler for Car Journals.

Trolley-Car Battleship

THE vessel here depicted looks like a warship at sea. The sharp prow seems to be cutting through the waves at a high rate of speed. The waves are of papier-maché, as is the hull of the vessel itself. It is what is called the "trolley-car battleship," although the only indication of the trolley is to be seen in the pole which projects from between the funnels. The vessel and waves were constructed over the platform of an electric car, covering it with the exception of a small portion of the wheels. The funnels and pipes were made of sheet brass, the rigging of fine wire, and the masts of wood. It is intended to represent the United States battleship *Wisconsin*, and carries the same number of steel guns

A Battleship in Street Parade:
Model of U. S. S. *Wisconsin* that recently attracted much attention in Milwaukee.

and is modeled in the same proportion as that ship. This unique vessel was built at Milwaukee, Wis., and used in a recent street parade in that city, where during the night procession it attracted much attention.

A New Sediment Trap

IN our large cities the subject of a pure water supply presents a serious problem. A patent recently allowed to a Cleveland inventor, provides a simple and effective device for arresting all solid matter that may enter the water pipes of a residence or other building.

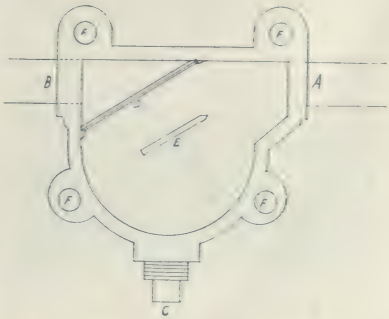
The accompanying drawing shows the plan of this "Sediment Trap," as it is called. It is made of cast iron, one-fourth to five-sixteenths of an inch thick and one and seven-sixteenths inches deep, inside measurement.

The water enters at A and passes out at B, thus having a direct flow. D is a narrow frame covered with a fine wire screen, through which the water must pass and by which all solid matter is arrested and allowed to fall to the bottom of the trap. C is an outlet for the dirt, closed by a screw plug. E is a metal shield to prevent circulation of the water in the trap, and allows small fish or such things as might swim into the trap, to swim out again.

To clean the trap, shut off the supply pipe at the cut-off, then open the plug C; the backward flow of the water in the pipes will wash the dirt out from the trap. Should it be desired to clean the trap or the screen, the face may be taken off by unscrewing the bolts F F F F. The wire screen can then be removed if desired.

This device has successfully stood a two weeks' test by the Water Works Department of the City of Cleveland, Ohio, and is highly recommended by the Superintendent. In the City Council of Cleveland, there was considerable debate about the unsanitary method of water meters, insomuch that the screen in the meters stopped and collected all the vegetable and animal matter, and the flow of water had to sift through this dirt, thereby contaminating the water with decaying filth.

All former devices on the market had this same defect, of keeping the dirt in the flow of the water. Moreover, it takes an expert to clean any device used at present; but in the case of the above patent, any one can do the cleaning. All he has to do is to turn off the water and take out the plug, and the back flow of the water will do the rest.—T. L. Edwards, Student, American School of Correspondence.



Sediment Trap.

It effectually removes all solid matter from passing water, and is easily cleaned.

As Others Might See Us

THE ATTITUDE which we assume in making quick movements is seldom noted by the eye itself on account of the rapidity of the motion. It has remained for the camera to catch and reproduce such images on the negative plate with a faithfulness that proves the shapes are not exaggerated. Until the invention of the high-powered lens and the rapid shutter of the camera, no one knew how awkward are the movements of the horse, for example, in trotting or running; and the artists who had attempted to represent these motions discovered that they had an entirely wrong conception.

The curious attitudes assumed in leaping have also been shown by the camera, as is indicated by the picture here reproduced, which is a "snap shot" taken of five men who attempted to jump into the water simultaneously. They made the attempt feet first, but, as the photograph

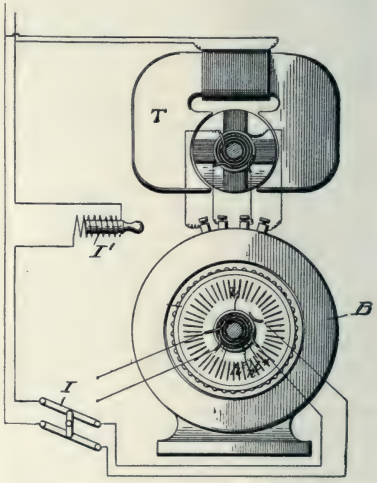
As Others Might See Us.

Actual positions caught by the camera.

shows, entered the water in various attitudes, far from graceful. The picture is an excellent illustration of the law of gravitation, for the heaviest men were placed at the ends of the row, and both entered the water before the others. The picture was taken by a shutter which is claimed to cover the lens in one thousandth part of a second.

Self-Starting Single-Phase Motor

A SELF-STARTING, single-phase induction motor is announced as the invention of M. C. Massie. The motor, shown at *B*, is provided with a double-wound stator, like that of a machine intended to be started by means of a phase "splitter," and a rotor having a squirrel-cage winding and also an ordinary closed-circuit or ring winding. The latter is connected to two pairs of collector rings, one for running forward, and the other for rotation in the opposite direction. A rotating field is set up in the stator by means of a peculiar transformer *T*, having a stationary primary winding and two secondary windings, the latter mounted on a revolvable core like the armature of a motor. The two secondary windings are set at right angles to each other; consequently, when one is in position for maximum induction, the other is in the neutral position. The transformer armature is mounted on the same shaft with, or otherwise rigidly driven by, the rotor of the induction motor *B*. The taps from the collector rings of the motor to its ring winding are located so that when one of the transformer secondaries is in the most favorable position and is delivering maximum E. M. F. to the corresponding stator winding on the motor, the polar axis of the rotor ring winding is in the most favorable position for torque, due to the field of the then active stator winding. The machine, therefore, starts up, and the rotation of the transformer armature produces a rotating field in the motor stator which is always just ahead of the polar axis of the rotor ring winding. The switch *I* is for reversing the motor, by shifting the rotor supply current to



Self-Starting Single-Phase Motor.

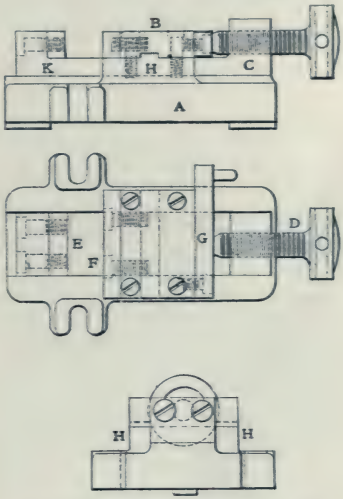
the other pair of slip rings. The adjustable inductance *I'* is for regulating the torque of the rotor. At full speed the switch *I* is opened, leaving the machine a simple induction motor.

Efficient Machine Vise

EASILY CONSTRUCTED and simple of operation, this vise has been used for highly accurate interchangeable work, and has given perfect satisfaction. The body, *A*, is of cast iron, and is secured to the platen by two slotted ears, with bolts in the usual way. Two cheeks *H* provide a support for the cover-plate *B*, which is slotted to fit the tongue on the cheeks and is secured by four screws. These cheeks also form a guide for the slide *C*, which is made of mild steel and slides on the facing *K*, on the body. A hardened steel jaw-face *E*, is fixed with two screws to *C;* and another, *F*, is in like manner fixed to cover-plate *B*. The end of the slide is tapped for screw *D*, which is used with a "tommy," and has a hardened point that forces against latch *G*, fastened to the cover-plate, thus drawing the slide and clamping the work against the fixed jaw *F*. The latch is used to facilitate withdrawing work and to save backing the screw, it being necessary only to slack the screw and swing back the latch, so that on pushing the slide the work may be withdrawn, the space then allowing the fingers to grip the article. For larger work, however, the latch is not necessary. The loose jaws can be made in a variety of forms to suit different work.

A Radium Clock

THE LATEST NOVELTY announced in the field of invention is a radium clock. It is based on a somewhat unique application of the principle of radio-action. and is the invention of an Englishman. The device comprises a small tube, in which is placed a minute quantity of radium supported in an exhausted vessel by a quartz rod. To the lower end of the tube—which is colored violet by the action of the radium—an electroscope, formed of two long leaves or strips of silver, is attached. A charge of electricity in which there are no Beta rays, is transmitted through the action of the radium into the leaves; and the latter



SECTIONAL VIEW OF HANDY MACHINE VISE.

thereby expand until they touch the sides of the vessel, connected to earth by wires, which instantly conduct the electric charge, whereupon the leaves fall together. This simple operation is repeated every two minutes until the radio-active powers of the radium are exhausted.

As the life of this wonderful newcomer among the so-called "elements" is variously estimated at from 30,000 to 100,000 years, it is easy to see how the new type of clock, if commercially practicable—which is yet to be demonstrated—bids fair to make old Father Time himself cut his beard and throw away his trusty scythe. The clock maker and repairer will be driven out of business; and the venerated "grandfather's clock" will give way to heirlooms in the hands of descendants whose lines of ancestry will have been as irremediably lost as are those of the Shepherd Kings who invaded Egypt.

INDUSTRY AND COMMERCE

Latest in Mural Decorations

STYLES IN WALL PAPER change nearly as often as do the fashions for women's dresses. At present the raging demand in Europe is for pearl, white moire, and striped papers—styles that were popular in the sixties—with hand-stenciled and landscape-friezed borders.

The landscape frieze has made rapid progress of late. One of the reigning designs of Europe is shown in Fig. 1. The best of the landscape designs are adaptable to the length of surface to be decorated. When a landscape frieze is used, the space to be covered must be carefully considered, because the effect would be ruined if part of the design were to be seen "going around the corner," so to speak. The design shown in the accompanying illustration is so arranged that portions of the drawing may be left out or added to, as may be desired. If, for example, the length of the room is considerable, and there is no break, two bridges or even three may be introduced, while in a smaller space one would suffice. In either case the landscape would be complete. This ingenious arrangement is brought about by certain features, such as the skyline, being, in certain places, of exactly the same height, so that part may be cut out if desired.

Sometimes the result is obtained in an entirely different way. The design is so arranged as to consist of half a dozen or so different parts, each one separate from the others. When the space is limited, these figures are brought closer together than before by cutting away portions of the paper intervening. A very successful specimen of this kind of design is executed by hand by means of stencils. It consists mostly of outlines of vessels of various sizes. In order to cope with the problem of dealing with spaces of different sizes, the artist arranged to omit or add to the number of vessels; and a further difference is made by changing the position of some of the outlines, so that no two lengths of this particular design are exactly alike.

Fig. 2 is an example of hand-work stencil frieze, the distinguishing features of which are the bold drawing and the

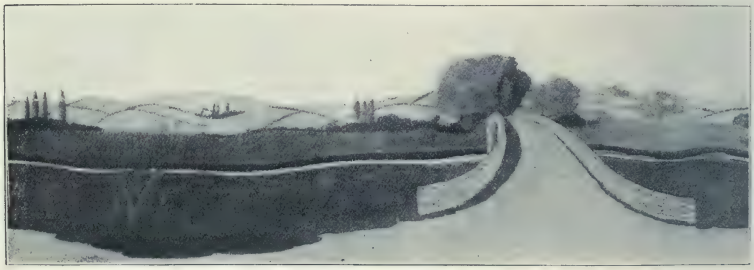


FIG. 1. MODERN LANDSCAPE FRIEZE.

splendid coloring. Friezes of this design are usually employed over plain grounds such as ingrain paper, and they produce excellent effects. The blending of colors is done by hand, and cannot be successfully copied by machine work. Even where actual blending is not employed, the graduation of color is used. Some of the figures shown in the design are thus graduated in color from dark to light. This is effected by using a very moderate amount of color on the stencil brush, and this becomes almost exhausted before the lighter portions are reached.

FIG. 2. HAND-STENCILED FRIEZE.

Another recent departure in wall decoration is the use of coarse fabric, one of the best known varieties of which is called "fab-ri-co-na." This is pasted on the wall and gives a level surface of great durability. It serves the useful purpose of preventing the wall from cracking. The fabric is most frequently used without ornament, thus producing a very rich and dignified appearance and proving very durable. The texture is purposely made coarse in order to break up the surface, which it does most effectually, adding greatly to the artistic effect of the decoration considered as a whole.

Still another important departure in the treatment of mural surfaces, is the use of what are known as "water paints," which have grown in popularity of late. They may be described as "washable distempers," but they are greatly superior to ordinary distempers in fineness and finish. Very charming results are frequently obtained by their use.

Cost of Firing Cannon

SOME IDEA of the cost of modern warfare can be arrived at by taking a Japanese warship like the *Kasuga* or *Nisshin* and calculating the number of shots it would discharge. The first-named ship carries four cannon which cost $30,000 each. One of these guns can fire two shots per minute, and every shot costs $400; thus in five minutes these four cannon can discharge forty bombs at a cost of $16,000. The smaller cannon cost each $18,000, and every shot they fire means an expenditure of $70. They are rapid, and it is estimated that in five minutes the twelve cannon could discharge shot to the value of nearly $35,000.

State Monopolies in France

AT PRESENT the monopolies of France consist of the postal and telegraph and telephone services, the striking of money, the manufacture and sale of powder, tobacco, and stamps. No one complains of the state handling of the issue of coin; neither does anyone complain of its working of the powder trade; but the complaints on each of the other heads are never-ceasing; and one needs only to have tried to talk by telephone, attempted to strike a French match, or had the misfortune to smoke a French cigar, to know how well founded the complaints are. The one open defense the Government offers for them is that they constitute a form of indirect tax-

ation which is acceptable to the French taxpayers.

The real cause of the continued existence of these monopolies, is the political wire-pullers; and it is because of the new opportunities which a fresh monopoly would afford, that the wire-pullers welcome enthusiastically an audacious project which is now being matured, to be ready for the reopening of the Chamber —which is nothing more nor less than the turning of all insurance business in France into a government monopoly.

Extraordinary as such a move would be, it is not impossible that the French Parliament will accept it.

A Chinese Printer's Task

THE CHINESE, who are said to have invented printing, have made little progress in its development. Setting type by the Chinese method is a slow process. The Chinaman's "case" is a whole room. The walls of the room, up to the height of the compositor's head,

CHINESE PRINTER AT HIS CASE.

are made slanting; and there the 5,000 or 6,000 characters are divided off into classes by partitions.

The American printer has all the type in a small case in front of him, and can easily reach every letter with one hand without moving from his seat. The Chinese printer may go to one corner of the room to get one type, and then to the opposite corner to get the next type. Even with this slow process, the Chinaman has made considerable improvement over his former methods, by employing the American "stick," "forms," "composing stone," and "keys," and a press similar to the American make. The Chinese compositor carries the copy in his head, for the Chinaman has a wonderful memory. This he must have in order to learn the language and to become familiar with the thousands of characters necessary to read and write. The printer looks at the copy once, and is able to set up an entire article of, say 500 words, without consulting it again.

The Telephone in the Alps

THE TELEPHONE has robbed Alpine heights of some of their terrors. Two alpestrians lately lost their way on the great St. Bernard mountain. Wandering for hours in a fierce snowstorm they at last reached one of the newly built shelters erected by the monks. There they found not only food and a lamp, but also a telephone connected with the hospice. They called up the monks; and soon one of the Brothers appeared, accompanied by two St. Bernard dogs, and conducted the men to the hospice, where they received the proper care. Many huts with telephones have been built in exposed places, and a number of lives have thus been saved.

Egyptian Rags

HUNDREDS OF TONS of Egyptian rags are imported every year into the United States to supply the paper mills. At Mannheim-on-the-Rhine, American importers have rag-picking houses, where rags are collected from all over Europe, the disease-infected Levant not excepted, and where women and children, too poor to earn a better living, work day after day with wet sponges tied over their mouths, sorting these filthy scraps for shipment to New York. The best grades of paper are made from these rags. The common grades are made from wood pulp, which is obtained by grinding and macerating huge blocks from very soft wooded forest trees.

Lay Excursions in Science

Second Paper

By CHARLES PIERCE BURTON

Author of "The Bashful Man and Others"

IT IS NATURAL, perhaps, that the spectacular in science should impress the layman. He becomes interested, even fascinated, at once by liquid air and all its manifold possibilities which the imagination can suggest—and a well-developed imagination in a layman can suggest many things. In this he has an advantage over the scientist, who is obliged to chain down his imagination to demonstrable facts. But there is nothing in scientific achievement or endeavor which so appeals to the lay public as the thought of airships and the whole question of aërostation.

When Santos Dumont steers his dirigible balloon around the Eiffel Tower, the whole world wonders and applauds, although this same world may not be on speaking terms with the law of gravitation. Laymen, in all ages since that wonderful triumph of science, the sea-going ship, made man master of ocean as well as of land navigation, have watched with longing eyes and souls on fire the flight of birds through the impalpable atmosphere.

"O, that I had the wings of a dove!" sang the Psalmist, that most human and most god-like of the ancients, three thousand years ago. And these words have echoed in human hearts ever since. But not until comparatively recent times has navigation of the air seemed possible.

The imagination of the ancients pictured Dædalus and Icarus as flying with manufactured wings. The latter flew so near the sun that the waxen wings melted, and he was precipitated into the sea, there to become an island—not the worst fate that could befall a man. Yet, so impossible did the achievement seem even in those days of robust imaginations, that only the greatest of the gods had the power of flight. To-day, however, when men of recognized scientific standing are experimenting more or less successfully with aëronautics, there is hope that the imagination of the layman will soon become a fact of science, and the world will move on to another era.

To a layman, nothing so greatly emphasizes the difference between the scientific world of to-day and the epoch immediately preceding, as the exhibit of flying machines or airships at the Louisiana Purchase Exposition in St. Louis. That the American Congress should experiment in that direction is no cause for wonder when we have seen this same Congress bombarding the offending atmosphere in vain efforts to produce rain. But when a hurdle race of airships is actually made a part of the program at an international exposition, in the expressive language of the day, "there is something doing."

Think of it! Flying machines! And constructed with the approval of science! Only a few years have passed since "Darius Green and his flying machine" started from the barn and fell into ignominy. But here in the twentieth century, Professor Langley launches his airship and falls into glory. In the nineteenth century, public opinion, regardless of its hopes, was prone to class promoters of the flying machine with those of perpetual motion, which has always had such a fascination for laymen, notwithstanding. It seemed like flying in the face of Providence, so to speak.

As a matter of fact, successful air sailing is only a little more than a century old. At the beginning of the sixteenth

century, an Italian chemist in Scotland tried to fly to France; but, while his idea was commendable, the execution was disastrous. The law of gravitation refused to make an exception and suspend operations in his case, and so he fell, breaking the bone of his thigh. The trouble seems to have been, according to the prevailing belief, not in the idea but in the construction of the wings. In this important matter he used rooster instead of eagle feathers—an inexcusable blunder. The flight of the eagle is well known and phenomenal. On pinions strong he rises through space as if to reach the very sun. But the rooster is satisfied if he can manage to get over the barnyard fence. How could mortal man expect to fly with such a handicap? The rooster feathers pulled him down. The audacious Italian cleared the fence, then straightway commenced wallowing and scratching in the neighbor's garden.

Not until June 5, 1783, was the first balloon ascension made by two daring brothers named Stephen and Joseph Montgolfier. It is a noteworthy fact that their success was largely due to "hot air." Since then the balloon has been a factor in the scientific world, as well as an important adjunct to the phenomenon known as the county fair, and "hot air" has become one of the world's great motive powers.

But balloons are one thing, and airships something entirely different. How to steer these balloons, that is the question. The balloon will never become popular as a means of conveyance until it can be depended upon to run on something like schedule time and to arrive somewhere near its destination. What will it avail to ascend into the air, no matter to how great altitude, if you have to walk back? The layman does not care whether the ascent is made by means of a gas bag or an inclined plane, if only he can navigate the air and enjoy some new sensations. I'll stake my scientific reputation on the prediction that this will some time happen. Man will some day be master of the air as he is now of land and ocean.

There are some of us even now who have no patience with phenomena like airships, although, if the truth were known, we have been chasing them under some other name all our lives, and shall keep on in the pursuit until we ourselves become airships and take our flight from this world of care and mystery. Yet, there is nothing unreasonable in the thought of an airship. The mystery lies in the fact that man has not succeeded in flying before this. Since Elijah of old made his spectacular ascent into Heaven, we have been trying to "get off the earth."

The world is full of mysteries, and one more or less cannot matter. Man himself, the greatest mystery of all, spends his brief existence working out their solution, and with every discovery makes the mystery more profound. Could we clear up all of the enigmas, life would lose much of its spice. Still, among the other mysteries, it must be confessed that the term airship has a peculiar flavor, and we roll it beneath the tongue with special unction.

It is so in keeping with our longings and aspirations. Think of it! To mount through space! To leave behind this world of care and trouble for a brief period of rest beyond reach of the smoke and dirt of civilization! To pass even beyond the clouds that in their purity o'erhang the earth as great, white-winged thoughts o'erhang the soul! What hopes and aspirations would come to us in that ethereal retirement! Methinks, as the ancient giant, ignoble son of earth, took on new bodily vigor with every contact with the soil, so should we, exalted sons of Heaven, expand in mind and soul with every flight.

O, the airships of life—hopes and aspirations, vain imaginings of things to be, which uplift the soul! These, after all, are the real things. The great dream life is the real life, and the daily experience is the dream. From childhood to age we sail these ethereal seas. Fortunate is he who can sail on schedule time; who can translate these hopes and ideals into experience; who, far from the sordidness of earth, can "hitch his wagon to a star" and arrive at his destination.

Costume and Custom

The Strange Practice of Tattooing — A Survival of Barbarism that Has Its Counterpart in the Modern Passion for Fashionable Bodily Adornment

DECORATING THE FACE AND FORM has been a human weakness since the earliest knowledge of man. The same innate vanity that prompts the woman of certain parts of the globe to paint her cheeks a roseate hue, to punch ear-ring holes in her ears, wear sparkling diamonds, and bind her waist in a vise-like encasement to mould its outlines, causes the women and men of other regions to paint their faces and forms most glaringly and in many-hued designs, to carve their skins, and to decorate their persons with feathers and rings. The Chinese woman who incases her foot in iron slippers to keep them small, laughs at the American woman who binds her waist, thus cramping and restraining the growth and actions of the vital organs; and the American woman who binds her waist laughs in turn at the Chinese woman who is so foolish as to restrict the growth of her feet. The Marquesan or Japanese who tattooes her whole body with brilliant images of birds, leaves, and animals, thinks she is supremely beautiful and the envy of all women who do not endure the torture of similarly decorating themselves.

TATTOOED MARQUESAS ISLANDER

Excessive decorating of the body with knife, paint, and ornaments is practiced by nearly all savages, but gradually diminishes among a people in proportion to their advancement in civilization. Returning to the custom is said to be an unmistakable sign of degeneracy. This is one reason why the woman of to-day is in general said to be inferior to the man, and why she is said to resemble more closely the savage.

Tattooing is one of the most ancient and general methods of personal ornamentation. In Japan and the Marquesas Islands it has reached its most advanced stage; but there, like everywhere else, it is confined to the ignorant and uncivilized. In Japan, tattooing is often made a substitute for clothing. The custom prevails throughout Polynesia, but is most popular in the Marquesas Islands. There, many persons may be found with every part of the body decorated, from the crown of the head to the toe nails. There, as well as in certain parts of Japan, some of the women wear nothing but a small cloth around their waists,

SPECIMENS OF JAPANESE TATTOOING

sometimes carrying an additional wrap which they can throw over their bodies to keep off the hot sun. The accompanying illustrations from the *Scientific American* aptly depict the practice. Women sometimes have their tongues tattooed as an expression of grief for loss of their husbands.

Tattooing is one of the most painful of tortures. The principal motive of its origin was to leave a perpetual evidence on the body, of the physical suffering the person had undergone to prove his fortitude. Many instances have occurred, however, when the young warriors have been overcome by the agony, have fled from the scene of the operation, crazed with pain, and hence have ever afterward been despised as cowards.

The operator, called the "Matai," first traces out his pattern on the skin, and, this being done, commences to drive his toothed tattooing comb into the flesh. This comb is made of many fine cambric needles firmly bound to a piece of bamboo about seven inches long. In this process is used a mallet with which the Matai strikes the comb sharp and rapid taps, driving the needles deeply into the flesh. Assistants are ready with strips of white "masi" to clean off the blood as it flows from the wounds. It usually takes an hour to tattoo a space three inches square, which generally is as much as is done at one operation. The "patient" returns every week or two until the operation is completed. One payment is demanded before the first "sitting;" and when the operation is about half done, another is asked for. If this is not made, the operator refuses to complete the work, and the young chief may be left "half dressed," so to speak, for the rest of his life. Therefore the payment, as a usual thing, is promptly forthcoming. Although the victim suffers indescribable agonies while the operation is in progress, he glories in the achievement when the work is completed, as it signifies his admission to manhood and makes him the more admired by the women. Cinnabar and India ink are the ingredients used. Tattooing among women is more popular in Japan than in Polynesia.

Metals Under the Microscope

Beautiful Crystalline Construction Often Explains Mooted Mysteries

WONDERFUL APPEARANCES and conditions in the construction of metals are revealed through the microscope, an instrument that has lately added a hundred-fold in interest to the study of metallurgy. If you have never examined a piece of iron or steel or zinc or other metal with the microscope, you have no idea of the beauty or nature of its real construction. You may find it to be something entirely different from what you thought it was; and in the sight you see, you may discover the explanation of many strange characteristics of metals that you have marveled at before.

Microscopic examination of polished and etched specimens of metals shows most intricate and extremely minute variations in their internal structure. A noted French metallurgist who studied the direct reduction of iron from its ores, and who followed the successive changes by the aid of the microscope, has this to say:

"If to these analytical data, observations under the microscope with a magnification of 300 to 400 diameters be added, it is seen that ordinary iron is merely a metallic network with a close-grained tissue and submerged scoriaceous opaline, sometimes subcrystalline, portions, with little globules and metallic grains arranged in every direction. Sometimes nests of translucent prismatic and bacillary crystals, with metallic portions adhering, are noticed hidden in the paste; these are grains of steel which can be made to disappear by heating."

Dr. Sorby says: "Steel must be regarded as an artificial crystallized rock." The keynote of metallurgy may be found in these words.

Until recently the applications of the metals to the arts and sciences have been based almost wholly upon the results of chemical analyses and certain mechanical tests involving breaking strength and limit of elasticity. But chemical analysis can only partially determine the constitution and physical properties of complex bodies; it can take no account of the mechanical treatment the metal has undergone in the process of manufacture Hammering, rolling, squeezing, drawing, annealing, etc., induce changes which profoundly modify the elasticity and other physical properties, though they do not in the least change the ultimate chemical composition. The effects of impact, torsion, alternations of stress, and excessive strain, can be appreciated only

Tin Crystals in Tin Plate. | Crystal Grains in Cast Silver. | Mild Steel after Annealing at 700° C.

STRUCTURE OF METALS AS REVEALED BY THE MICROSCOPE.

when the changes of structure induced in the metals affected are fully known. In such cases the application of the microscope renders a most valuable aid in elucidating the source and nature of these changes, inasmuch as it reveals to the eye

An Iron Crystal.
Seen under the Microscope.

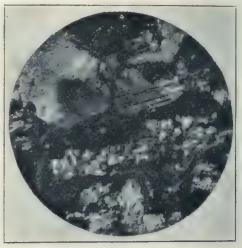
the altered configurations of the constituent bodies.

The most important results of the microscopic investigation of metals have been obtained from the study of alloys, whose properties largely depend upon their physical constitution. The alloy at present claiming chief attention is steel, with its great variety of structures, differing not only with each content of carbon, but also with that of other constituents either adventitious or purposely added to produce a given effect. That the nature and arrangement of structure is by far the most important factor in determining physical properties, is becoming more evident every day; and most of the researches of metallographists are conducted on this assumption, for it certainly enables one to explain many problems otherwise insolvable, such as the cause of cracks, breakage, and other defects in samples of similar chemical composition.

Another illustration may be taken from the case of the bearing metals used for reducing friction. These alloys are found to consist of different constituents varying in hardness; and the load of the journal is carried through them by the hard component of the alloy, which is found to possess a low coefficient of friction, the plasticity of the matrix making it possible for the bearing to adjust itself closely around the shaft. The plasticity may be ascertained by means of compression test, but the nature of the constituents must be determined by microscopic examination.

The manner in which crystalline structure in metals is developed varies; but the main factor is temperature. The more slowly a metal is cooled from the melting point, the larger will be the dimensions of crystals, the more perfectly will they be formed, and the more symmetrically will they group themselves together. On the other hand, if a metal be submitted to pressure, not only will the individual crystals be distorted, but the orderly arrangement of the whole mass will be disturbed; and when the pressure is carried to a certain extent, the metal will become so weak as to be easily fractured by a slight additional force. Now, as the crystalline condition is the natural state of a metal, any deviation from this will be unnatural. In that case the molecules are ever tending to pass back again to the normal state, which is perfectly effected by remelting.

When a piece of iron is strained in tension, its crystal grains become elongated in the direction of tension; but when the specimen has subsequently been annealed



Micro-structure of Granite.

by being heated to a bright red heat, all signs of elongation disappear from the crystalline pattern revealed by the microscope, and the metal has resumed its original condition. In investigating metals under strain, it is found that when the metal is stretched beyond its elastic limit, sharp black lines appear on the sur-

face of the crystals, parallel to one another in each crystal, but in different directions in different crystals. They then look like a crevassed glacier, and the lines like cracks. These lines, however, are not cracks, but "slips" along the cleavage, or gliding planes, and are termed "clip-bands." Such bands are produced also by compression or torsion, and it is in virtue of this action that plasticity in metals is possible. Prolonged annealing tends to produce large crystals in iron and steel, but even a short exposure to a suitable temperature produces complete recrystallization.

For the exact examination of the structure of metals with the microscope, it is necessary to have the specimen perfectly flat and free from scratches, as scratches tend to mask the real structure; further, flatness enables all the parts to be properly focused under the microscope—an indispensable condition when photography is used. The section, for convenience, should be about half an inch square and one-eighth of an inch thick.

Technical Training Pays

Interesting Facts Revealed by Studying the Earning Capacities of the Graduates of One Important American Technical School

TECHNICAL SCHOOL GRADUATES possess an enormous advantage over all their competitors in the engineering world, according to careful averages that have just been made by President Dodge of the American Society of Mechanical Engineers, showing the following annual earning capacity of the different classes of workmen:

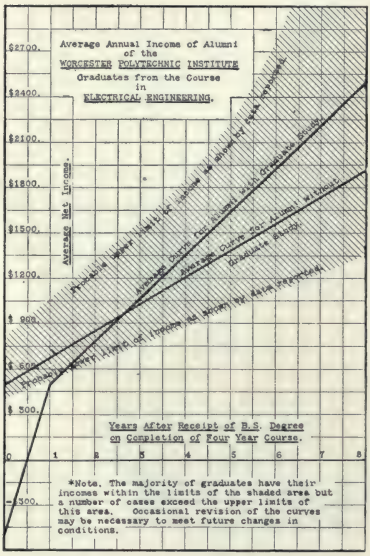
Technical school graduate, average wages $2,150.00.

Shop-trained workman, average maximum wages $790.00.

Unskilled workman, average maximum wages $510.00.

Of course, there are unskilled workmen and shop-trained workmen who make much more than the figures indicate; but these show truthfully the average maximum wages received by them. Further, President Dodge finds that the unskilled man has reached his maximum earning capacity of $510 at the age of 22 years. This, capitalized at 5 per cent, gives him a potential value of about $10,000. The shop-trained man reaches his maximum of $790 per year at 24 years of age. The wages of the technical school graduate are still rising at 32 years of age, when he receives an annual income of $2,150, which gives him a potential value of $43,000 when capitalized at 5 per cent.

The accompanying diagram, prepared from data received from graduates in Electrical Engineering of the Worcester (Mass.) Polytechnic Institute, substantiates the conclusions of President Dodge, and further emphasizes the ad-


Average Annual Income of Alumni of the WORCESTER POLYTECHNIC INSTITUTE Graduates from the Course in ELECTRICAL ENGINEERING.
$2700.
$2400.
$2100.
$1800.
$1500.
$1200.
$ 900.
$ 600.
$ 300.
0
Average Net Income.
Years After Receipt of B.S. Degree on Completion of Four Year Course.
1
2
3
4
5
6
7
8
*Note. The majority of graduates have their incomes within the limits of the shaded area but a number of cases exceed the upper limits of this area. Occasional revision of the curves may be necessary to meet future changes in conditions.

vantages of a thorough technical training. The diagram is unique, showing very completely the financial prospects of technical graduates from year to year. The Department of Electrical Engineering of the Worcester Polytechnic Institute has been established but eight years, and hence there are data available for this period only; but during this time a large number of students have graduated, and data have been received from a sufficient number of them to make a fair representation of existing conditions. From the curves it is seen that the average graduate who receives $500 per year for his first position after leaving the Institute, rapidly increases in value, so that at the end of eight years he may expect to receive an income of about $1,900; or if he has been a graduate student for one year, his income is shown to average about $2,500, which, capitalized at 5 per cent, gives him the income on an investment of about $50,000. By investing five years of his time and the cost of his college training, he has, after a few years, and for the remainder of his life, increased his income-earning value by not less than $40,000. That the investment is a good one, goes without saying.

The Turbine Steamer "Brighton"

A New Addition to the Channel Passenger Fleet

THE LONDON, BRIGHTON & SOUTH COAST RAILWAY of England has always provided excellent means of transportation for the traveling public. The accompanying illustration of the turbine steamer *Brighton* is an example of how this enterprising company, in coöperation with the Western Railroad of France, takes care of the channel traffic between Newhaven & Dieppe.

The *Brighton* is fitted up in the most sumptuous manner; and, as is now usual, the first-class accommodation is placed forward of the engines and boilers. The dining saloon, on the main deck, is fitted with dull-polished oak carved in Elizabethan style, and is provided with a number of small tables. On the promenade deck, which runs the whole length of the ship, are a large first-class smoking saloon, a handsomely decorated ladies'

boudoir, and a number of private state-rooms. On the after part of the main deck, ample provision is made for second-class passengers, including separate saloons for ladies and gentlemen and a smoking room.

TURBINE STEAMER *BRIGHTON.*

Belonging to the London, Brighton & South Coast Railway, and plying across the English Channel.

The usual triple-expansion engines are replaced by turbine machinery on the latest improved plan, designed by the Hon. C. Parsons, whose genius has completely revolutionized the problem of high-speed marine engines. The main engines of the Brighton consist of three separate turbines, each driving its own line of shafting and propeller. On this boat, however, the passenger will hardly be aware of the presence of anything in the nature of engines, owing to the total absence of vibration and to the machinery not being in evidence to either the visual or the olfactory nerves. The new steamer is outwardly very like her predecessor, the *Arundel;* is 282 feet long, 34 feet broad, and of about 1,100 tons' register. She has a speed of over twenty-one knots, and is a steady sea-boat.

Do It Now

If you've got a job to do,
Do it now!
If it's one you wish was through,
Do it now!
If you're sure the job's your own,
Don't hem and haw and groan—
Do it now!

The Suez Canal

A Waterway Assuming Vaster Commercial Importance Each Year

THE SUEZ CANAL has been in existence for so many years that in a large measure the public fail to realize that its commercial importance is still in its infancy.

The thin ribbon of water which unites the Orient and the Occident, we recognize as a great engineering feat of the past; but the fact that vast schemes to develop this international property are going on under the direction of the Suez Canal Company, is something that seems to be lost sight of in the newer interests of the Panama Canal.

It is at Port Said, at the Mediterranean mouth of the Suez Canal, that this development is most apparent. The old, ill-famed, dirty town, full of the human scourings of the Levant, has given place to a comfortable city of well-wooded streets and many fine buildings. Along the water-front there still stretches a medley of one-storied houses, but the directors of the Suez Canal Company are laying plans that will in time transform Port Said into a Mediterranean Singapore.

On both sides of the northern end of the canal, and on what is generally, although inaccurately, known as the African side, the existing dockage in the Arsenal and Commercial basins is to be greatly enlarged. On the eastern bank a very much larger project is in contemplation. The directors have decided on the immediate construction of an enormous coal dock, 2,112 feet in length and 1,137 feet in width. This will take the place of the existing basin.

Another matter affecting Port Said is the continual choking up of the entrance to the breakwater, owing to the strong easterly current along the shore of the delta at the mouth of the Nile. This water, of course, is heavily charged with alluvial earth, and the deposit sometimes exceeds one and a-half inches in twenty-four hours. To overcome this, two of the most powerful dredges yet designed have been constructed, and have proved themselves capable of dealing adequately with the deepest deposits.

Another important improvement is to be the relaying of the narrow-gauge railroad which runs from Port Said to Ismailia. This road was originally built as a construction line for the use of the workmen on the canal; but, as the trade of Port Said has increased, the traffic has become so great that the directors have decided to lay a 4-foot 8-inch gauge road, and to run their trains in connection with the Egyptian government railway.

Within the next five or six years, the Company hopes that the canal will be widened to its utmost limit so that the largest ships will then be able to pass each other at almost any point between Port Said and Suez.

Dredging has already deepened the canal to the uniform depth of about 28 feet, and it is the purpose of the directors ultimately to have a clear foot of water below the bottom of the largest steamer that has yet been launched.

It has also been discovered that the fringe of reeds which grow on the African side of the canal below Ismailia, forms a better protection for the banks than the courses of expensive sun-dried brick or sandstone in use elsewhere. An attempt has been made to grow these reeds in other parts of the canal; but the difficulty has been found that the reeds, although they will afterwards adapt themselves to and flourish in salt water, must originally be grown in fresh water, and there is no fresh water on the Asian shore of the canal from end to end.

Another achievement of the Canal Company is the stamping out of malaria at Ismailia, and turning one of the most fever-stricken spots in Northern Africa into a health resort. This was accomplished by Dr. Ross, by filming over with

petroleum all the stagnant water in the district. This is perhaps the best-known work of the Suez Canal Company and has had a wide pathological importance.

Those developments have been carried out very quietly and with no blare of trumpets; yet, even with what has already been accomplished, the commercial interests of the Suez Canal are still in their infancy.

A Hero

BOYS sometimes think a hero's
A man of giant might,
A warrior of armor,
A champion for the right,
Who through the world goes boasting
That wrongs shall be no more,
The story of whose exploits
Is sung from shore to shore.

In olden times a hero
Was such a man, I know;
He went to battle aided
By javelin and bow.
You all have heard of Ajax,
Of Priam's valiant son,
And of the great Achilles,
Who many battles won.

But now, to be a hero
Is quite another thing,
And he who earns the title
Is nobler than a king—
'Tis he who follows duty,
Who scorns to be untrue,
Who's guided by his conscience—
Not by what others do.

And you may be a hero,
By doing all you can
To free the world from error,
And aid your brother man.
And, though no blast of trumpet
Your greatness may proclaim,
With heartfelt benedictions
Mankind will breathe your name.

The Embryo Electrical Engineer

Some Sound Advice Based on Experience

ONE OF THE MOST PERPLEXING of all the requests for advice or information that are received at this office, is the letter asking us to advise a young man what course to pursue in order to become an electrical engineer, the means for taking a collegiate course not being available; also to suggest the best branch of electrical work. It is, of course, impossible for us to offer much specific advice in such cases; without knowing intimately a young man's natural characteristics, one cannot intelligently suggest what avenue of work would be apt to suit him best, and there is no "best branch" of the electrical industry from any other standpoint. Naturally, we advise taking up a course of study with some *correspondence school,* if one cannot have the advantage of personal tutelage; and when this is said, it exhausts the possibilities in the way of specific advice under the circumstances.

Generally speaking, technical education is absolutely necessary to even mediocre success in any branch of electrical or other technical work; with a given amount of honesty, intelligence, and industry, the better the education, the greater the measure of success. By "education" we do not mean necessarily college advantages, valuable though they are; some of the highest-grade men in the electrical field are self-educated, and some of the most hopelessly incompetent boast college degrees. With the facilities that now exist for acquiring technical education, there is no excuse whatever for anyone to remain wholly ignorant of fundamental principles and their application. But the road to complete qualification as an electrical engineer is not an easy one; and while there is always "room at the top," there is no room in the class of the poorly qualified—no demand for the mediocre engineer.

If one elects to become an electrical engineer, therefore, the standard should be set very high; and the aspirant must determine to sacrifice everything except personal character, if need be, to the drudgery of acquiring the necessary mental training and practical experience. These may possibly be acquired simultaneously, but it is usually necessary to obtain the mental training first. Detailed advice as to just what steps to take in order to secure the requisite knowledge and experience is out of the question; a man's resources, environment, and restrictions chiefly determine this, and these are seldom combined in the same way twice. Moreover, a man who possesses the personal qualities essential to thorough success does not require to be steered along from point to point in his upward course.—*American Electrician.*

In order to receive attention, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender*. In view of the fact that the inquiries already received have far exceeded the available space, the Editors reserve the right to select for publication only those inquiries likely to be of greatest interest to the readers of the magazine in general. Other inquiries will be answered by letter.

Gas-Engine Indicator Diagrams

Question: Please explain how to calculate a theoretical indicator diagram for a gas engine when the cylinder, diameter, stroke, and volume of clearance only are known. Also, how to calculate volume of clearance required, when the diameter, stroke, and desired compression, gauge pressure, only are known. An answer to the above would be of great service to me, especially if it can be done without using logarithms.—*F. A. D.*

Answer: The mathematical formulæ appertaining to the computation of the element of heat, and its work in an explosive engine, are in a large measure dependent upon assumed values, because the conditions of the heat of combustion are made uncertain by the mixing of the fresh charge with the products of a previous combustion and by absorption, radiation, and leakage. The theoretical diagrams can be laid out by assuming the compression and expansion to be adiabatic. Assuming the action to take place as stated, approximate cards can be drawn, but results of any value cannot be obtained without the use of logarithms. The relation of pressure and volumes is expressed by the formula

$$P\,V^{1.41}=P_1V_1^{1.41}$$

By plotting pressures vertically and volumes horizontally, different points on the curves of compression and expansion can be found and laid out to the scale assumed. At the end of the stroke we know the total volume, and the pressure is that of the atmosphere. Then at ½ of the return stroke, the volume will be 2-3 of what it was at the beginning, if the clearance is ½ the total piston displacement. Calling the original volume 1, the volume at half stroke would be 2-3. The original absolute pressure is 14.7 pounds. Then in the formula given above we have:

$$P\times(\tfrac{2}{3})^{1.41}=14.7\times1^{1.41}$$

From this,

$$P=14.7\times(\frac{1}{\frac{2}{3}})^{1.41}=14.7\times(1.5)^{1.41}$$

This is easily solved by logarithms, for we have:

$$\text{Log } P=\log 14.7+1.41 \log 1.5$$

Knowing the logarithm of P, P itself can readily be found.

In the second case, we have to find the volume when the pressure on the compression curve has risen to a certain amount. The original pressure and volume may be called P and V respectively, P being 14.7. The final pressure and

volume are P_1, which is given, and V—S, V being the same as before, and S the piston displacement, which is known. These values can then be substituted in the formula given above, which is solved as before.

Effect of Ground—Need of Insulation

Question 1: Will a heavy ground on the primary line of an alternator open the main circuit-breaker?

Question 2: Is it necessary to place some kind of insulating material between the sub-base of an alternator and the foundation stone?—*L. H.*

Answer 1: If the machine or circuit is not otherwise grounded than at one point, the main circuit-breaker will not open; in other words, there must be a ground on each side of the line in order to cause a short-circuit and throw the circuit-breaker.

Answer 2: This can best be decided by referring to the Underwriters' rules on this subject, which read as follows:

"Generators must be thoroughly insulated from the ground wherever feasible. Wooden base-frames used for this purpose, and wooden floors which are depended upon for insulation where for any reason it is necessary to omit the base-frames, must be kept filled, to prevent absorption of moisture, and must be kept clean and dry.

"Where frame insulation is impracticable, the Inspection Department having jurisdiction may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

"A high-potential machine, which, on account of great weight or for other reasons, cannot have its frame insulated from the ground, should be surrounded with an insulated platform. This may be made of wood, mounted on insulating supports, and so arranged that a man must always stand upon it in order to touch any part of the machine."

Testing Rivet Steel

Question: Please inform me through the columns of THE TECHNICAL WORLD, as to what is the way of testing a piece of rivet steel at the forge.—*D. R. B.*

Answer: There is a great lack of uniformity in the rules prescribed by different writers and by legislation, for testing rivet steel. All materials entering the construction of boilers for marine vessels must be constructed according to the regulations prescribed by the Board of Supervising Inspectors of Steam Vessels. The Board of Trade rules regarding rivet steel are as follows:

The tensile strength of rivet bars should be between 26 and 30 tons. Elongation in 10 inches not less than 25 per cent, and the contraction of area not less than 50 per cent. Lloyd's rules, tensile strength 26 to 30 tons, elongation not less than 20 per cent in 8 inches. The material must stand bending to a curve the inner radius of which is not greater than ½ times the thickness of the plate after having been uniformly heated to a low cherry red and quenched in water at 82° F.

Another test requires that the rivets shall be capable of being flattened out cold under the hammer to a thickness ½ the diameter, and of being flattened out hot to a thickness of 1-3 the diameter, without showing cracks or flaws.

Boiling Point of Gasoline

Question: I am interested in the gasoline engine, and should like to know the answers to the following questions:

1. How many cubic inches of gas, at atmospheric pressure will a cubic inch of gasoline generate, providing the temperature remains constant?

2. At what temperature will gasoline boil at atmospheric pressure?

3. How many cubic feet of air at ordinary temperature and atmospheric pressure are required to completely burn one cubic inch of gasoline?

4. What is the increase in pressure of a properly proportioned charge of air and gasoline?—*H. P., Jr.*

Answer 1. The vapor of commercial gasoline at 60° F. is equal to 130 volumes of the liquid.

2. Gasoline boils at from 140° to 158° F., depending upon its specific gravity. The higher the specific gravity, the higher will be the boiling point.

3. Since the ordinary gas requires about 9 volumes of air for its complete

CONSULTING DEPARTMENT—(Continued)

combustion, it would therefore require 130×9(=1,170) cubic inches of air for the vapor produced by 1 cubic inch of gasoline. This is equivalent to .68 cubic foot of air.

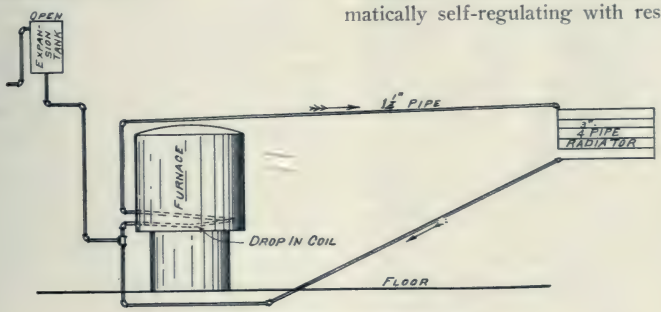
4. This question is answered in the September number of THE TECHNICAL WORLD, page 95.

Hot-Water Circulation

Question 1: Does water in a hot-water heating system circulate just as fast under the city pressure as it does with the pressure of only a few feet head?

I am in doubt as to whether to connect the system to the water tank in the kitchen or to a separate expansion tank. I do not intend to circulate the water through the tank in either case.

Question 2: Is it necessary to have the coil in the furnace, used for heating the water, at all points above the point of entrance, when the point of entrance is higher than the lowest point on the system—that is, in a gravity system? See sketch.—*L. A. O.*



HOT WATER CIRCULATION SYSTEM.

Answer 1: We give, in the accompanying sketch, the best of the two plans you have submitted.

The circulation of hot water in any system depends only on the difference in temperature of the water in the supply and return pipes, since the greater the difference in temperature, the greater the difference in weight, and circulation is due to the pressure caused by the difference in weight. The circulation can be obtained in either way, but for most cases it would not seem advisable to connect up to the city mains. In other words, the heating system should be distinct, an expansion tank being used to take care of the increase in volume. If connected to the kitchen tank it would probably interfere with the water back.

Answer 2: While it may not be absolutely necessary to have every part of the coil in the furnace above the point of entrance, yet it would certainly be best to have a constant pitch upward. The mains are always inclined upwards from the heater, and the returns inclined downward and connected with the heater at the lowest point.

Relation of Armature Current and Load

Question: How is it that the amount of current which the armature of a direct-current motor takes, depends on the load applied at the pulley?—*B. E. J.*

Answer: The electric motor is automatically self-regulating with respect to the amount of current it takes for a given load. If we increase the load, the current automatically increases; and if we decrease the load, the current automatically decreases. If the load is increased, the speed drops and the counter-E. M. F. decreases—which allows the current to increase until the required torque is obtained. It is also evident, from the law of conservation of energy, that the current must increase with the load, otherwise the motor would be giving out a

CONSULTING DEPARTMENT—(Continued)

greater amount of power, without increase in the amount applied.

Mechanical Stokers on Locomotives

Question: Have experiments been tried with mechanical stokers on locomotives? If so, why is their use not practicable?—*E. W. C.*

Answer: Owing to the fact that there are so many faults in their mechanical construction, these stokers have not proved very efficient, except in the case of slow firing. Where rapid firing is required, as on locomotives, it would hardly be practicable to use them.

Adjusting Current for Fan Motor

Question 1: What effect would an alternating current at 110 volts and a frequency of 60 cycles have on a fan motor designed for 52 volts and 125 cycles?

Question 2: What effect would it have on one designed for 110 volts and 125 cycles?

Question 3: What device can be used to adjust the difference?

Question 4: How does the choke coil in an alternating enclosed-arc lamp adjust the frequency of the current?—*J. B.*

Answer 1: It would cause the motor to heat very badly, because both the magnetic flux and the current would be high. Also, the speed would be decreased approximately one-half.

Answer 2: Heating would occur, but to a less extent than in the first case. The speed would also be decreased to about one-half.

Answer 3: In supplying 110 volts to the 52-volt motor, you could use a resistance to cut down the voltage to the proper amount; but there is no practicable way of compensating for the difference in frequency.

Answer 4: The choke coil in an alternating enclosed-arc lamp does not adjust the frequency of the current, but must itself be adjusted to suit the frequency. If the frequency is low, more turns must be used; and if high, fewer turns must be used.

Specific Gravity of Electrolyte

Question: The weight of the electrolyte in a storage cell of the E 11 Chloride Accumulator type, is 26 pounds. I find the specific gravity of the electrolyte, when cell is fully charged, to be 1.205. How much pure water (specific gravity 1.000) must be added to make the specific gravity of the electrolyte 1.200?—*M. D. H.*

Answer: This calculation may be made as follows: Let x equal the volume of water; and let y equal the volume of the electrolyte. Then we can form the equation:

$$x \times 1 + y \times 1.205 = (x + y) \times 1.2$$

Then,

$$x + 1.205\,y = 1.2x + 1.2y;$$

or,

$$.2x = .005y;$$

and,

$$\frac{x}{y} = \frac{.005}{.2} = \frac{1}{40}.$$

In other words, the volume of water to be added is 1-40th of the volume of the electrolyte. Now, the electrolyte weighs 26 pounds; an equal volume of water, then, would weigh $\frac{26}{1.205}$ pounds; and the amount of water to be added would be 1-40th of this, or .539 pound.

This result is approximately correct, and is probably near enough for all practical purposes, although it neglects the fact that there is a slight change in volume on mixing the sulphuric acid and water, and it also neglects any temperature allowance.

Limitations of the Rotary Engine

Question: Why is a rotary steam engine so little used?—*B. D. F.*

Answer: The problems involved have been numerous, and their solution peculiarly difficult. Chief among these has been the question of securing steam-tight joints between the moving element and the containing shell or casing, the rate of movement at such joints being so high

as to prohibit any known method of providing a working contact. All possible designs of rotary engines have seemed to embody essentially a variety of evils, such as unbalanced lateral pressures exerted upon large areas of the revolving part; wasteful port passage and cylinder clearance; contracted passages requiring steam to flow at impossible rates; mutually acting cycloidal members subject to heavy unbalanced pressures tending to force them apart; sliding vanes or wing-pistons subject to centrifugal strains with consequent excessive friction and vibration.

Many mechanisms have been constructed; but the long record of failure has led most practical engineers to believe that the problem cannot be solved in the present state of mechanical development. The distinct advantages of the rotary type are so obvious that new designs are constantly being turned out, and there is reason to think that improvement will go on steadily until satisfactory results are obtained.

Storage of Explosive Mixtures

Question: Can a tank be filled from the explosion of gas or gasoline to a reasonable pressure, say 200 pounds to the square inch? If so, can that pressure be carried to the piston head in a cylinder? If so, what per cent of loss would there be in so doing? If neither can be done, please explain why not.—*A. C.*

Answer: The tank can be filled with a mixture of gas and air, and the mixture exploded. This would cause a rise of pressure, and, if the pressure were carried to a piston in the cylinder, work could be done. The general principle of the action is the same as that in the ordinary gas engine of to-day, except that the explosive charge is not compressed before explosion. For ordinary operations, the action referred to would not be practical. In the first place, if a large amount of energy is to be stored, the tank would necessarily be of large proportions, and, as the pressure rises, the mechanical difficulties would be almost too great to be overcome. Again, when the mixture is exploded, not only does the pressure rise, but the temperature also rises to a very high point. It would be impossible, economically, to keep this heat from being lost. This loss of heat which would take place constantly, would affect the economy and would make the whole operation inefficient. This system is quite similar to the method of using compressed air. We have reference to the storage of air in tanks from which it is fed to the cylinders of engines and performs work in the same manner as steam in expanding.

Wiring of Packing Plant

Question: I have a packing house to be wired. It was formerly wired with weather-proof wire supported on porcelain insulators. The rosettes, insulators, and wires next to the insulators, became covered with salt, which caused the wire to be grounded. Would it be advisable to incase the wires in an approved moulding with shellac, or would it be better to expose the wires supported on porcelain?—*A. S.*

Answer: It would not be advisable to use moulding in this case, as the moulding will absorb moisture, especially in the presence of salt, and will thus become a first-class conductor. It would be better to use approved ceiling rosettes and the best of rubber-covered wire on insulators at the required height. You must, of course, follow the Underwriters' rules for wiring in damp places, using keyless sockets and approved construction throughout.

Size of Boiler Safety Valves

Question: What is the proper size of safety valves for boilers?—*R. S. D.*

Answer: Three square feet of grate surface is usually allowed for one inch area of spring-loaded valves, or two square feet of grate surface for one inch area of common lever valves.

Nurnberg Gas Engine

Question: Is the Nurnberg Gas Engine single- or double-acting, and on what principle do the cylinders work?—G. J.

CONSULTING DEPARTMENT—(Concluded)

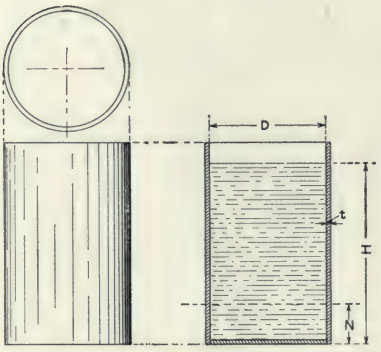
Answer: It is a double-acting tandem, and the cylinders at both ends work on the four-cycle principle. An excellent article on the Nurnberg Gas Engine appears in the September, 1904, issue of *Modern Machinery*, published in Chicago; price, 10 cents per copy.

Formulae for Tanks or Stand Pipes

Question: Kindly explain if the following formulæ for tanks are correct, and why they are so:

(a) T = 0.00006184 × H × R.
T = Thickness of shell plate in inches at different heights.
H = Height in feet.
R = Radius in inches.

(b) Strain per sq. in. = D × H × 2.6 lbs.
D = Diameter in feet.
H = Height in feet.—*Tk. Mr.*



Answer: The formula *(a)* is approximately correct, and agrees very closely with the one given in Kent on page 294, but in a different form. This formula is derived as follows: Assuming any length of the section, as N, shown in the sketch, we have for the total resistance of the same $N \times t \times 2 \times 48{,}000 \times .6$. The section of the metal on each side of the tank is $N \times t$; and, since there are two sides, the total section is $2 \times N \times t$. Allowing a tensile strength of 48,000 pounds per square inch and an efficiency of .6 for a double-riveted lap joint, the total strength of the section of the tank mentioned is expressed as above. The terms t and N are each expressed in inches. The total strain on this section due to water of a head of H feet, is $H \times .433 \times N \times 12$ D. N is in inches as before, but H and D are in feet. Each foot of water corresponds to a pressure of .433 pound per square inch. Therefore the total pressure on the section under consideration is $H \times .433$ pounds. This is assuming that the maximum pressure is exerted throughout the length of the strip N, but of course it would not be quite as great at the top of the strip as at the bottom. The total pressure acting across a diameter, then, is $H \times .433 \times N \times 12$ D. Allowing for a factor of safety of 4, the total strain on the section N must be equal to ¼ of the resisting power of the metal. We have, therefore:

$$\frac{N \times t \times 2 \times 48{,}000 \times .6}{4} = H \times .433 \times N \times 12D.$$

Solving,

$$t = .00036 \times H \times D.$$

H is the height in feet, and D the diameter in feet. R is the radius in inches.

$$D = \frac{R}{6}.$$

Substituting, therefore, we have:

$$t = .00036 \times H \times \frac{R}{6} = .0006 \times H \times R.$$

This constant differs slightly from the one you have given. This is probably due to a different tensile strength being used or different factors of safety or efficiency.

Formula *(b)* does not appear to be correct, if we understand your meaning by "strain per square inch." Assuming this to be the strain per square inch of section of material, the formula should be expressed:

$$\text{Strain per square inch} = \frac{D \times H \times 2.6}{t}.$$

The total strain is, as before, $H \times .433 \times N \times 12$ D; and, dividing this by the total area in square inches, we would find the strain per square inch. This total area is $2 \times t \times N$. We have, then:

$$\text{Strain per square inch} = \frac{H \times .433 \times N \times 12D}{2 \times t \times N} = \frac{D \times H \times 2.6}{t}.$$

Personal and Miscellaneous

International Electrical Congress

THIS important gathering, which met at St. Louis, Mo., September 12 to 17, was a pronounced success, not being surpassed by any of those which had previously convened for similar purposes. A joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers of Great Britain was held in connection with the Congress. The total number of registered delegates was in the neighborhood of 900, of whom more than 700 were in attendance; and a total of 160 papers was read.

These papers had been planned with great care, and each one prepared by a recognized authority on the respective subject. The transactions of the Congress, which will be published later and distributed to the members, will contain all these papers and will form an extremely valuable volume. The papers were selected by the committee in charge, so that the authors represented as many different countries as possible, thus giving the broadest possible view of the various subjects discussed, and also giving a really international aspect to the transactions.

The Congress was divided into eight sections in order to facilitate the work. Wednesday, September 14, was "Electricity Day" at the Fair. There was no meeting of the Congress on this day, which was given over to a joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers of Great Britain. President Arnold of the former society gave his presidential address, in which he took up the probable future electrification of steam railways.

Among the prominent men who presented papers may be mentioned Mr. B. J. Arnold, Dr. Louis Bell, Prof. J. C. Kelsey, Mr. Philip Dawson, Mr. Kempster B. Miller, and Prof. C. P. Steinmetz. Mr. Kempster B. Miller's paper, which has since been published in various telephone and other electrical journals, was on "Automatic *vs.* Manual Systems of Telephony," and embodied an exceedingly able discussion of this most timely topic.

A Chamber of Delegates was formed on the first day of the convention. The following officers were elected: President, Prof. Elihu Thomson; Secretary, Dr. A. E. Kennelly; Assistant Secretary, Dr. F. A. Wolff, Jr. This Chamber of Delegates did not take any definite action with respect to units and standards; but, by unanimous vote, it was decided to appoint an International Governmental Commission to deal with the matter of electro-magnetic units. A resolution was also adopted that the various technical societies of the world should appoint an International Commission to take up the work of standardizing the nomenclature and readings of dynamo-electrical apparatus and machinery.

Wireless Telegraphy

THE successful transmission of messages by the DeForest wireless telegraph between St. Louis and Chicago on September 14, "Electricity Day" of the World's Fair, marks an epoch in the history of space telegraphy, as this is the longest land distance yet covered. The long-distance telephone was used to corroborate the telegraph messages, and two members of the award jury were in Chicago as witnesses, while many delegates

to the Electrical Congress were present at the sending station at the Fair. Various messages were transmitted from St. Louis, all of which were received in Chicago, readily and accurately.

At the conclusion of the test, the jury made a very complimentary report, and congratulated Dr. DeForest and his collaborators on their success.

APROPOS of the subject of wireless telegraphy, Prof. Dolbear, the eminent physicist of Tufts College, whose work along this line is well known, recently said: "Henry had to wait forty years before it was allowed that he was the inventor of the telegraph. I can wait 150 years for recognition as the discoverer of wireless telegraphy."

A Great Packing Plant

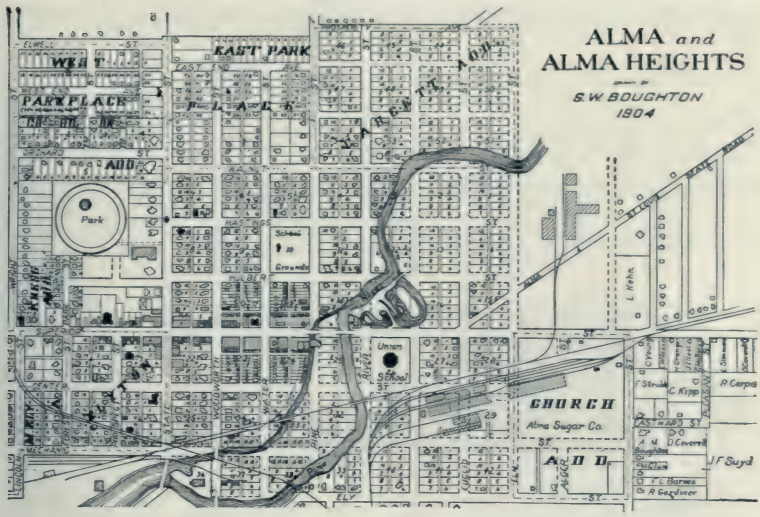
THE FOLLOWING DESCRIPTION of the offices of the great packing firm of Swift & Company is by William Johnson, an American School student in the employment of the Company:

The General Offices of Swift & Company are located at Exchange and Packers Avenues, in the Union Stock Yards, Chicago. The building is a modern five-story structure, being constructed of pressed brick, steel, and concrete, with stone trimmings and an ornate *porte-cochère*. In style and equipment it is of the best. Especial care has been taken in heating, ventilating, and sanitation.

The motor room is located in the basement of the building, and is equipped with the most modern machinery. The electric current used in the building is three-phase alternating, and comes from the power plant three blocks away. By means of transformers it is stepped up from 220 volts at the power plant, to 2,200 volts over the wires, and back to 220 volts at the office.

There are two 30-horse-power motors running two fans which supply the office with fresh air. The air is admitted through a large chute from the roof, which has two coils for tempering the air as it comes in. There is a 5-horse-power motor that runs a 4x6 triplex pump, which pumps calcium chloride through the brine pipes for cooling purposes; also one 10-horse-power motor for a 5½x8 triplex pump, for pumping water to the 3,000-gallon reservoir which is used to supply the restaurant and for other various uses. This tank is emptied

GENERAL OFFICES OF SWIFT & COMPANY, PACKERS, CHICAGO, ILL.



PORTION OF MAP OF ALMA, MICHIGAN.
Drawn by S. W. Boughton.

about every 35 minutes throughout the day.

The drinking water is distilled and sterilized by two distillers with a capacity of 15 gallons each per hour. This water is then forced through the pipes to the different floors.

There are also two 11-horse-power motors for two triplex pumps used to force the water through a set of spraying pipes, which purify the air before it enters the office.

In addition there is a large motor-generator set of 220 volts alternating current, which changes the power to 500 volts direct current, the latter being used for four 22-horse-power motors that operate the passenger elevators.

In case of fire there is a spraying system of 50 pounds' pressure that can be operated in ten seconds.

STANLEY W. BOUGHTON, of Alma, Michigan, a graduate of the American School, has drawn an excellent map of the city in which he resides. He made a canvass of the town, laying out all the new additions, streets, etc.; and, with permission to use the village records, he furnished an excellent map of Alma and Alma Heights. The map, of which we reproduce a section, is used by all the real estate agents of Alma, and has recently been adopted as the standard map of the town by the Alma Council.

S. W. BOUGHTON.

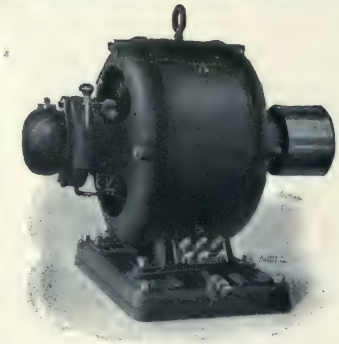
Personal Items

MR. F. R. PHILLIPS, of Newport, Ky., is now connected with the South Covington & Cincinnati Street Railway Company, as Master Mechanic.

MR. HORACE A. SUTLIFFE, formerly of Tacoma, Washington, has accepted a position as Master Mechanic with Bully Hill Copper Mining & Smelting Company, Winthrop, Cal. Mr. Sutliffe is a student in the Mechanical-Electrical Engineering Course.

Everything Electrical

Dynamos and Motors



Fans, Lamps and Telephones

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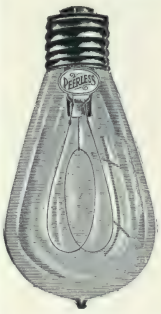

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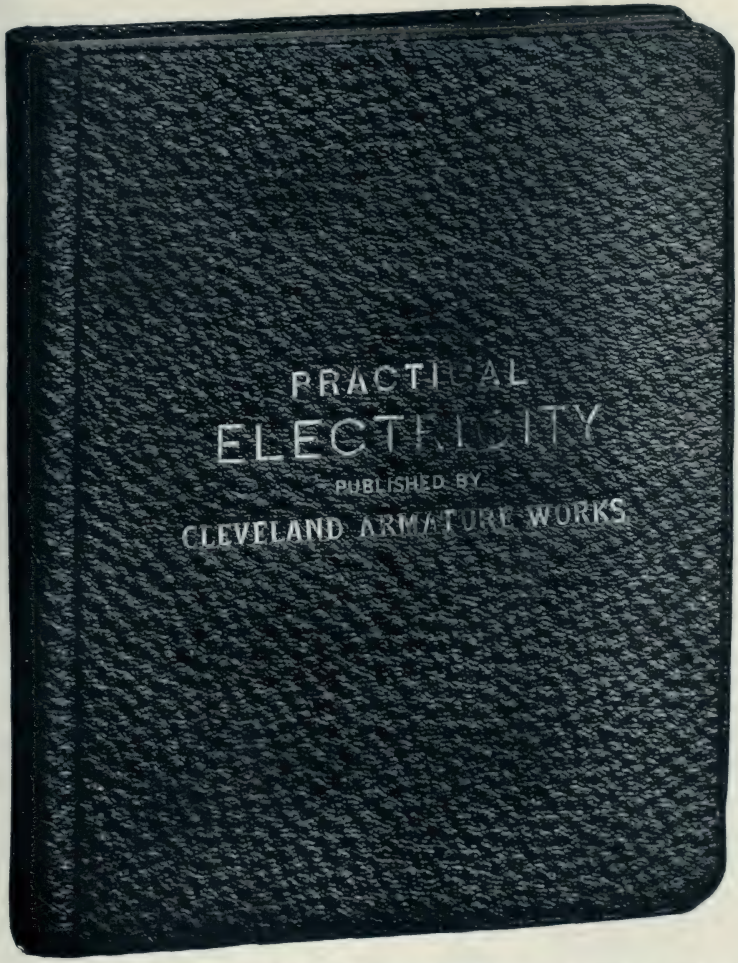

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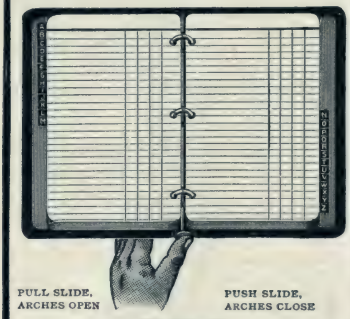

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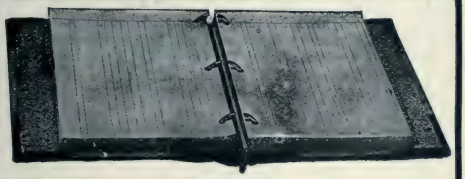

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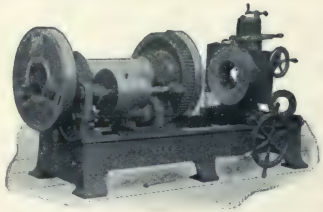

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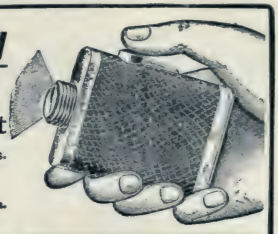

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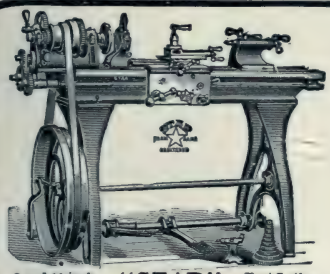

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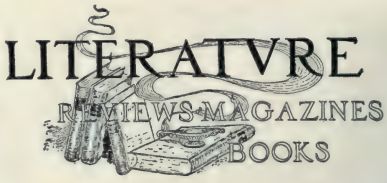

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Irrigation Engineering. By Herbert M. Wilson, C. E., Author of "Topographic Surveying," etc. Fourth Edition, Enlarged and Rewritten. Cloth. 8vo. Illustrated with 141 full-page plates and 142 figures. John Wiley & Sons, Publishers, New York, N. Y. Price, $4.00.

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Principles of American Forestry. By Samuel B. Green, Professor of Horticulture and Forestry, University of Minnesota; Member of the Forest Reserve Board of the State of Minnesota; Author of "Forestry in Minnesota." Illustrated. Cloth. 12mo. Pages 347. John Wiley & Sons, Publishers, New York, N. Y. Price, $1.50.

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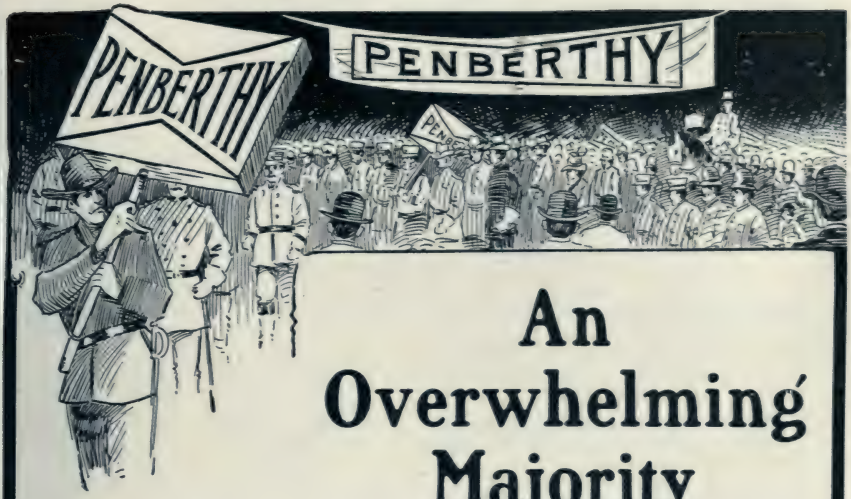

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The volume, though designed especially for students and others beginning the subject of Forestry, is also intended for the general reader who wishes to secure a broad idea of Forestry in North America. It covers the field in its entirety and with an abundance of detail too minute for mention here. Besides treating fully of the conditions of forest growth and management, it contains much information of practical value to the agriculturist, the engineer, the lumberman, and the woodworker. Illustrations are abundant, including many beautiful half-tones; and a complete analytical index renders all details easily available.

Elementary Woodworking. By Edwin W. Foster, Instructor in Shopwork and Drawing in the Manual Training High School, Brooklyn, N. Y. Cloth. 12mo. Pages 133. Illustrated. Published by Ginn & Company, Boston, Mass. Price, postage prepaid, 80 cents.

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A Treatise on the Construction and Use of Milling Machines Made by Brown & Sharpe Manufacturing Company. Paper. Illustrated. Indexed. Pages 188. Brown & Sharpe Manufacturing Co., Providence, R. I., Publishers. Price, 50 cents.

AS THE TITLE INDICATES, this book is devoted entirely to the milling machines made by this company. The fact that the book is written by the manufacturers is a guarantee of its absolute accuracy; and to anyone engaged in running one of these machines, which will be found in nearly every well-equipped machine shop, the book is invaluable, explaining clearly and fully, with diagrams, their principles and operation.

The book is written especially for those not familiar with the machines, with the object of aiding in having the machines well understood, properly cared for, and profitably operated. Going beyond this, the book contains much of interest and instruction to those who are well versed in both the theory and the practice of milling. Both the universal and the plain milling machines are taken up.

Among the many important operations described, may be mentioned the cutting of bevel gears, in the universal milling machine, also the cutting of spirals, as particularly interesting.

Japan as Seen by Great Authors. Edited by Esther Singleton. Pages 372. Dodd, Mead & Company, New York. Price, $1.60.

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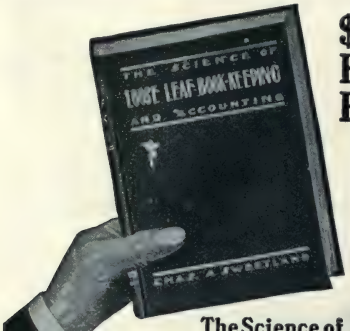

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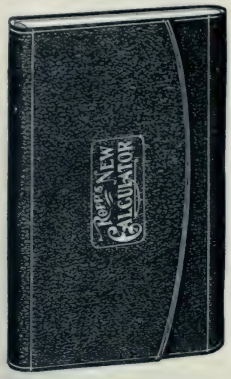
The article devoted to New Japan is of special value at the present time as it gives an insight into existing conditions and the spirit that animates the little island nation, whose fighting qualities have astonished the world.

Russia as Seen by Great Authors. Edited by Esther Singleton. Dodd, Mead & Company, New York. Price, $1.50.

THIS is a companion book to "Japan as Seen by Great Authors," but in our opinion is not so valuable a work. The book is not well balanced, several subjects of no special moment receiving too much space, and thus necessitating the curtailing of subjects which deserve a more extended treatment. One-third of the volume is occupied by descriptive articles on particular places, cities, the Volga basin, the Caucasus, the Trans-Siberian Railway, etc., followed by a number of chapters on the manners and customs of the people. Thirty pages are devoted to the discussion of the architecture, sculpture, painting, music, and literature of Russia; and the concluding chapter contains some statistics, and general encyclopedic and geographical information. The book is well illustrated with photographs. Many of the chapters are from the pens of such well known writers as Prince Kropotkin, Harry de Windt, Théophile Gauthier, and W. R. Morfill.



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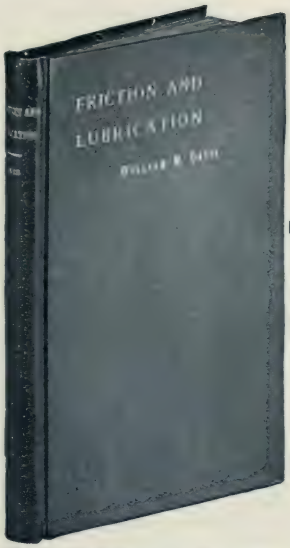

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Transformer Testing for Central Stations, by S. E. Johnneson.

Electrical World and Engineer (October 1)—New York

ONE OF THE LEADING ARTICLES of this number is that upon the Puyallup River Water-Power Development near Tacoma, Washington. The cities of Tacoma and Seattle have grown very rapidly in the past five years, and electrical developments have kept pace with this growth. The Puget Sound Power Company, the owner of the plant mentioned, was organ-

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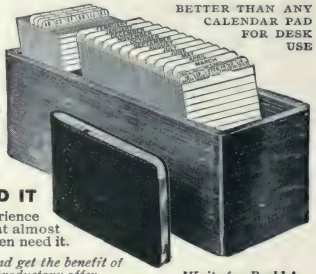

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LITERATURE—(Continued)

ized in 1902, for the purpose of developing water power for use in Seattle and Tacoma. It was planned to develop the power on the Puyallup river, beginning with 20,000 horse-power and increasing this finally to 40,000. The water is carried by means of a flume ten miles to a reservoir, thence discharging by means of steel pipes against wheels in the power house under a head of 872 feet. A current will be transmitted at a pressure of 55,000 volts, a maximum distance of 48 miles.

Considerable space is devoted to the International Electrical Congress; and reviews are given of different papers and discussions, such as that of Philip Dawson on "Electric Traction on British Railways," the addresses of B. J. Arnold, C. P. Steinmetz, etc.

An interesting description of Power Station Equipment for the World's Fair is given. It is noted that the total capacity of this station is 14,000 horse-power, the same as that of the Chicago World's Fair of 1893; but in the earlier case the generators were of 750 to 1,000 horse-power capacity, while at St. Louis the four 3,500-horse-power units are considered as of only moderate size.

The discussions on Telegraphy and Telephony at the International Congress are reviewed in an interesting manner.

Cassier's Magazine (October)—New York

IN AN ARTICLE entitled "The Auxiliaries of a War Fleet," by Archibald S. Hurd, it is shown that, besides the mere possession of ships, men, and guns, it is necessary to have an extensive organization between the headquarters of the fleet and the local depots; also auxiliary vessels to send to the men-of-war in case they are far from their base of supplies. Great Britain leads in the number of coaling and supply stations.

Considerable space is devoted to the article, "Fuel Gas for Gas Engines," by J. R. Bibbins, consisting of notes upon the generation of gas and its uses. Among the requisites for an ideal power gas are cheapness of generation, simplic-

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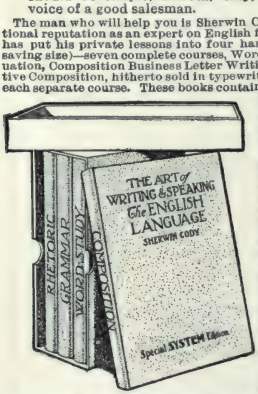

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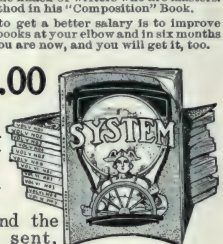

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"Building a Battleship in Twelve Months," by Joseph R. Oldham, N. A., consists of a criticism of American methods in respect to both length of time and amount of money required in construction of battleships.

The subject of wireless telegraphy is a popular one, and the description of the Wireless Telegraph Apparatus at the St. Louis Fair, by Cloyd Marshall, is interesting. It is stated that the wireless telegraph stations are the highest structures on the grounds, and form excellent observation points for the entire Exposition. The power supply for sending messages is 60-cycle alternating current from the Machinery Building, from which 100-volt current is used for the wireless telegraph transmitter. This is raised to 20,000 volts. The speed of transmission compares favorably with that obtained on the ordinary metallic circuit.

Other articles are:

New Grinding Machinery, by Charles S. Gingrich, M. E.

Water Supply of Modern City Buildings, by William Paul Gerhard.

Condensing Plant, by W. H. Booth.

CATALOGUES

The Globe-Wernicke Company, Cincinnati, Ohio. Filing Cabinets. Pages 92. Paper, 6 by 9 inches.

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Coffin Valve Company, Boston, Mass. Sluice Valves. Bulletin No. 6. Pages 82. Paper, 6 by 9 inches.

CATALOGUE illustrating and describing valves and devices, their general construction and practical application, with tables giving the principal dimensions

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LITERATURE—(Continued)

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Vitrified Wheel Company, Westfield, Mass. Emery and Corundum Wheels. Pages 52. Paper, 6 by 9 inches.

ILLUSTRATED CATALOGUE of emery wheels and corundum wheels made by the vitrified process, grinding machines, emery wheel dressers, emery wheel and corundum powders, saw gummers, etc.

Laidlaw-Dunn-Gordon Company, Elmwood Place, Ohio. Pages 168. Paper, 6 1-2 by 8 inches.

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A. L. Bemis, Worcester, Mass. Pages 32. Paper, 6 by 6 inches.

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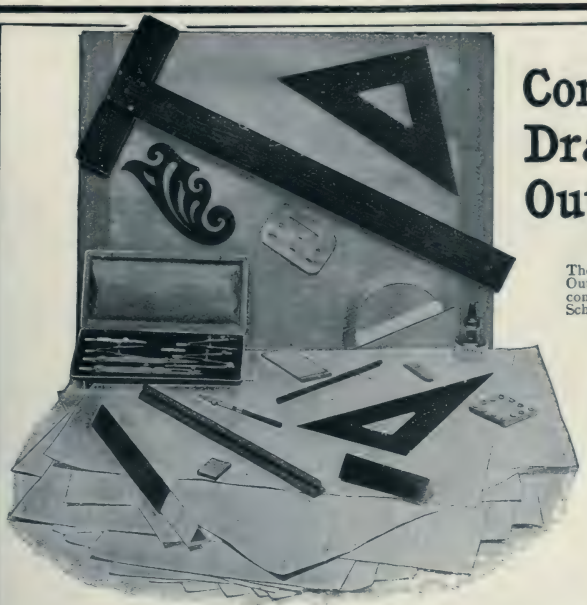

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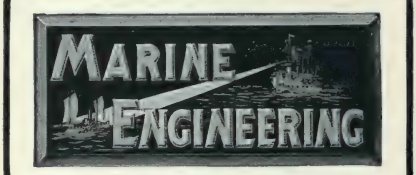

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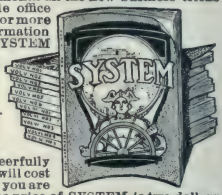

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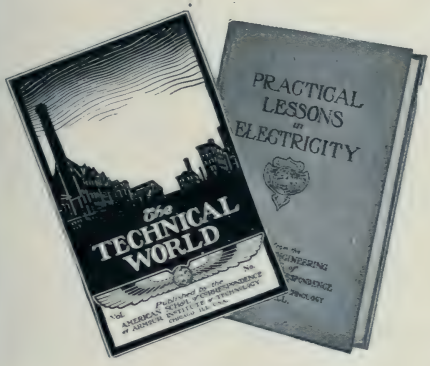

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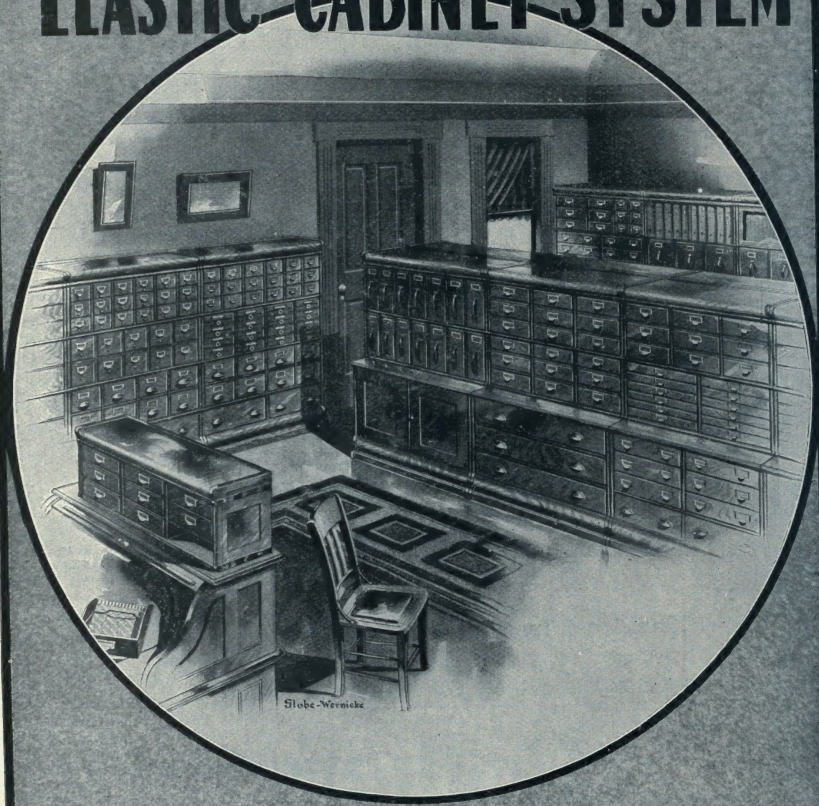

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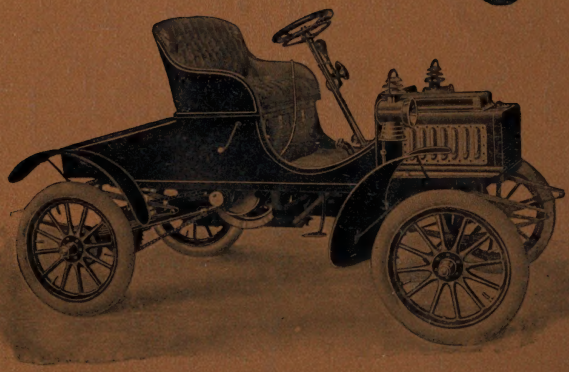

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